SCANNED
APR 0 3 1998
File # 6739

RECORD OF DECISION

HALBY CHEMICAL SUPERFUND SITE
WILMINGTON, NEW CASTLE COUNTY, DELAWARE

MARCH 1998

PREPARED BY
THE U. S. ENVIRONMENTAL PROTECTION AGENCY

RECORD OF DECISION
HALBY CHEMICAL SITE
OPERABLE UNIT #2

DECLARATION

SITE NAME AND LOCATION

Halby Chemical Site
Wilmington, New Castle County, Delaware

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the Halby Chemical Site ("Site") located in Wilmington, New Castle County, Delaware, developed and chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended ("CERCLA"), 42 U.S.C. §§ 9601 et seq., and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan ("NCP"), 40 C.F.R. Part 300. This decision is based on the Administrative Record for this Site.

The Delaware Department of Natural Resources and Environmental Control has concurred with the selected remedy (see attached letter dated March 30, 1998).

ASSESSMENT OF THE SITE

Pursuant to duly delegated authority, I hereby determine, pursuant to Section 106 of CERCLA, 42 U.S.C. § 9606, that actual or threatened releases of hazardous substances from this Site, as specified in Section VI (Summary of Site Risks), if not addressed by implementing the response action selected in this Record of Decision ("ROD"), may present an imminent and substantial endangerment to the public health, welfare, or the environment.

DESCRIPTION OF THE REMEDY

This second operable unit ROD is for the entire site and supercedes the first operable unit ROD. This selected remedy is intended to be the final response action for the Site. The selected remedy includes the following components:

- Cover the areas of the Site where soil exceeds 38 mg/kg arsenic with a paved cap.
- Excavate soil on the adjacent residential property that exceeds 14 mg/kg arsenic and combine with the contaminated soil under the cap.
- Backfill the residential property with clean soil, cover with six inches of topsoil and re-establish vegetation.
- Excavate the I-495 drainage ditch sediments, and place the sediments in the lagoon/marsh area.

- Backfill and level the lagoon and marsh with clean soil.
- Cap the lagoon area with a paved surface; cover the marsh area with topsoil and establish vegetation.
- Utilize a mobile water treatment plant to treat water taken from the lagoon and marsh, if necessary.
- Create/restore a compensatory wetland area at an off-Site location, preferrably tidal wetland/shallow water complex within the Christina River watershed, such that the functions performed by the existing 7 acre wetland and shallow water habitat to be eliminated are replaced.
- Install a system to control both storm water and soil erosion.
- Conduct long-term monitoring of ground water, sediment, surface water and created wetlands. Monitor and maintain the integrity of the containment components.
- Implement institutional controls in conformance with the ground water management zone established by DNREC encompassing the Site. Implement institutional controls to ensure that containment components are not compromised by future use of the property and any future subsurface work is completed in a manner protective of workers and the environment.

STATUTORY DETERMINATIONS

Pursuant to duly delegated authority, I hereby determine that the selected remedy is protective of human health and environment, complies with Federal and State requirements that are applicable or relevant and appropriate requirements ("ARARs") to the remedial action, and is cost effective. The principal threat presented by carbon disulfide contamination at the Site was addressed in an expedited emergency removal response action. The carbon disulfide removal was accomplished by implementing an innovative *in situ* chemical oxidation technology completed during the period between release of the Proposed Plan and issuance of this Record of Decision. The reduction of carbon disulfide was both permanent and utilized an alternative treatment technology. The remaining response actions at the Halby Chemical Site represented by the Selected Remedy do not independently satisfy the statutory preference for remedial actions in which treatment that reduces toxicity, mobility, or volume is a principal element; however, the remedy does utilize permanent solutions and alternative treatment technologies to the maximum extent practicable. See Section 121(b) and (d) of CERCLA, 42 U.S.C. § 9621(b) and (d).

Because this remedy will result in hazardous substances remaining onsite above health-based levels, a review will be conducted every five years after initiation of the remedial action in accordance with Section 121(c) of CERCLA, 42 U.S.C. § 9621(c), to ensure that human health and the environment continue to be adequately protected by the remedy.

Abraham Ferdas
Acting Director,
Hazardous Waste Management Division

3/31/98
Date

HALBY CHEMICAL SUPERFUND SITE
WILMINGTON, NEW CASTLE COUNTY, DELAWARE

RECORD OF DECISION
OPERABLE UNIT TWO
DECISION SUMMARY

TABLE OF CONTENTS

I. SITE NAME, LOCATION AND DESCRIPTION 1

II. SITE HISTORY AND ENFORCEMENT ACTIVITY 2

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION 4

IV. SCOPE AND ROLE OF THE RESPONSE ACTION 5

V. SUMMARY OF SITE CHARACTERISTICS AND EXTENT OF CONTAMINATION 6
- A. Site Characteristics 6
  - 1. Topography 6
  - 2. Surface Hydrology 6
  - 3. Hydrology 6
  - 4. Demography and Land Use 7
  - 5. General Site Geology 8
  - 6. Ecology 8
- B. Nature and Extent of Contamination 10
  - 1. Soil 10
  - 2. Sediment 11
  - 3. Surface Water 12
  - 4. Ground Water 13

VI. SUMMARY OF SITE RISKS 15
- A. Human Health Risk Evaluation 15
  - 1. Selection of Chemicals of Potential Concern 15
  - 2. Exposure Assessment 17
  - 3. Toxicity Assessment 18
  - 4. Risk Characterization 19
- B. Environmental Risk Evaluation 22
  - 1. Exposure Assessment 22
  - 2. Risk Characterization 23

VII. DESCRIPTION OF REMEDIAL ACTION ALTERNATIVES 24
A. Alternatives for Soil 25
B. Alternatives for the Lagoon and Marsh 29
C. Alternatives for Ground Water 34
D. Alternatives for DNAPL 38

VIII. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES 40
A. Overall Protection of Human Health and the Environment 42
B. Compliance with ARARs 44
C. Long-Term Effectiveness for Meeting Remedial Action Objectives and Permanence 46
D. Reduction of Toxicity, Mobility and Volume 47
E. Short-Term Effectiveness 48
F. Implementability 49
G. Cost 51
H. State Acceptance 52
I. Community Acceptance 52

IX. THE SELECTED REMEDY; DESCRIPTION AND PERFORMANCE STANDARDS 54
A. General Description of the Selected Remedy 54
B. Description and Performance Standard(s) of Each Component of the Selected Remedy 55
1. Cap Contaminated Soil with Paved Surface 55
2. Excavation of Contaminated Soil from Residential Parcel 56
3. Backfill and Cap Lagoon with Paved Surface 57
4. Backfill and Cover Marsh with Topsoil 57
5. Create Wetlands at Off-Site Location 58
6. Ground Water Management Zone 59
7. Long-Term Monitoring 59
8. Institutional Controls 60

X. STATUTORY DETERMINATIONS 61
A. Protection of Human Health and the Environment 61
B. Compliance with and Attainment of Applicable or Relevant and Appropriate Requirements ("ARARs") 62
C. Cost-Effectiveness 62
D. Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable 62
E. Preference for Treatment as a Principal Element 63

XI. DOCUMENTATION OF CHANGES FROM PROPOSED PLAN 63

RECORD OF DECISION
OPERABLE UNIT TWO
HALBY CHEMICAL SUPERFUND SITE

DECISION SUMMARY

I. SITE NAME, LOCATION AND DESCRIPTION

The Halby Chemical Site is located in a highly industrialized area near the Port of Wilmington, New Castle County, Delaware (see Figure 1). The 10-acre Site is generally bordered by Conrail tracks, Interstate 495, and Terminal Avenue, although the Site may be expanded to include the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for the implementation of the response action. The coordinates for the approximate center of the Site are 39°43'07" North latitude and 75°32'14" West longitude.

Major Halby Chemical Site features include three office buildings/warehouses housing at least five small businesses, and a lagoon with associated wetlands (see Figure 2). Subsurface utilities service the three buildings. In addition, a subsurface water main owned by United Water Company extends parallel to the railroad tracks and services the Port of Wilmington. Cover on the Site consists mainly of compacted gravel with little or no vegetation present other than along the perimeter of the lagoon. The former chemical production area, the southernmost 3-acres, and the southern end of the lagoon area is fenced.

Surrounding land parcels include a steel plant to the north, an asphalt plant to the south and the Potts Property State Superfund Site ("Potts Site") to the east. The Potts Site comprises the entire 72 acre parcel between the Halby Chemical Site and the Christina River. Other features adjacent to the Site include a diesel truck fueling station and a residential parcel with two trailer-homes.

Industrialization of the area began in the late 19th century; several nearby industrial facilities have risen and collapsed over the past 100 years. The Port of Wilmington area between Terminal Avenue and the Christina River was primarily marsh land until the wetlands were incrementally filled-in and built upon. The on-Site lagoon and perimeter wetlands comprised approximately 1.8 acres prior to any remedial measures. Currently, the on-Site lagoon is bermed and consequently isolated from the off-Site waterways; an emergency overflow spillway connects the lagoon to a storm water runoff ditch, which parallels I-495 and drains to the Christina River. In addition to the wetlands associated with the on-Site lagoon, approximately 5.2 acres of tidal wetland/shallow water habitat form a marsh located east of the railroad tracks on the Potts Site. Approximately half of the Site lies in the 100 year floodplain (i.e., lower than 10 feet above mean sea level).

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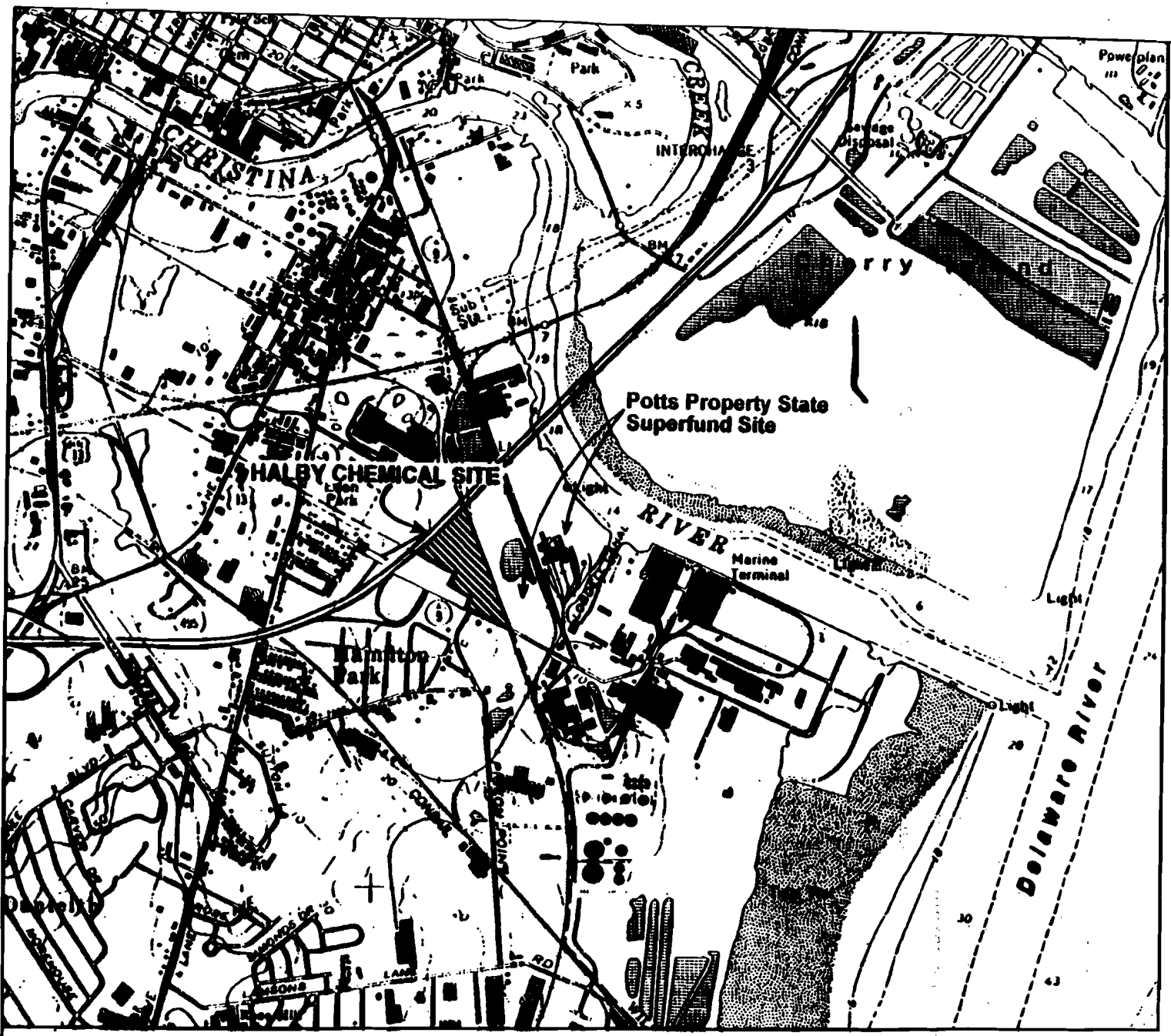

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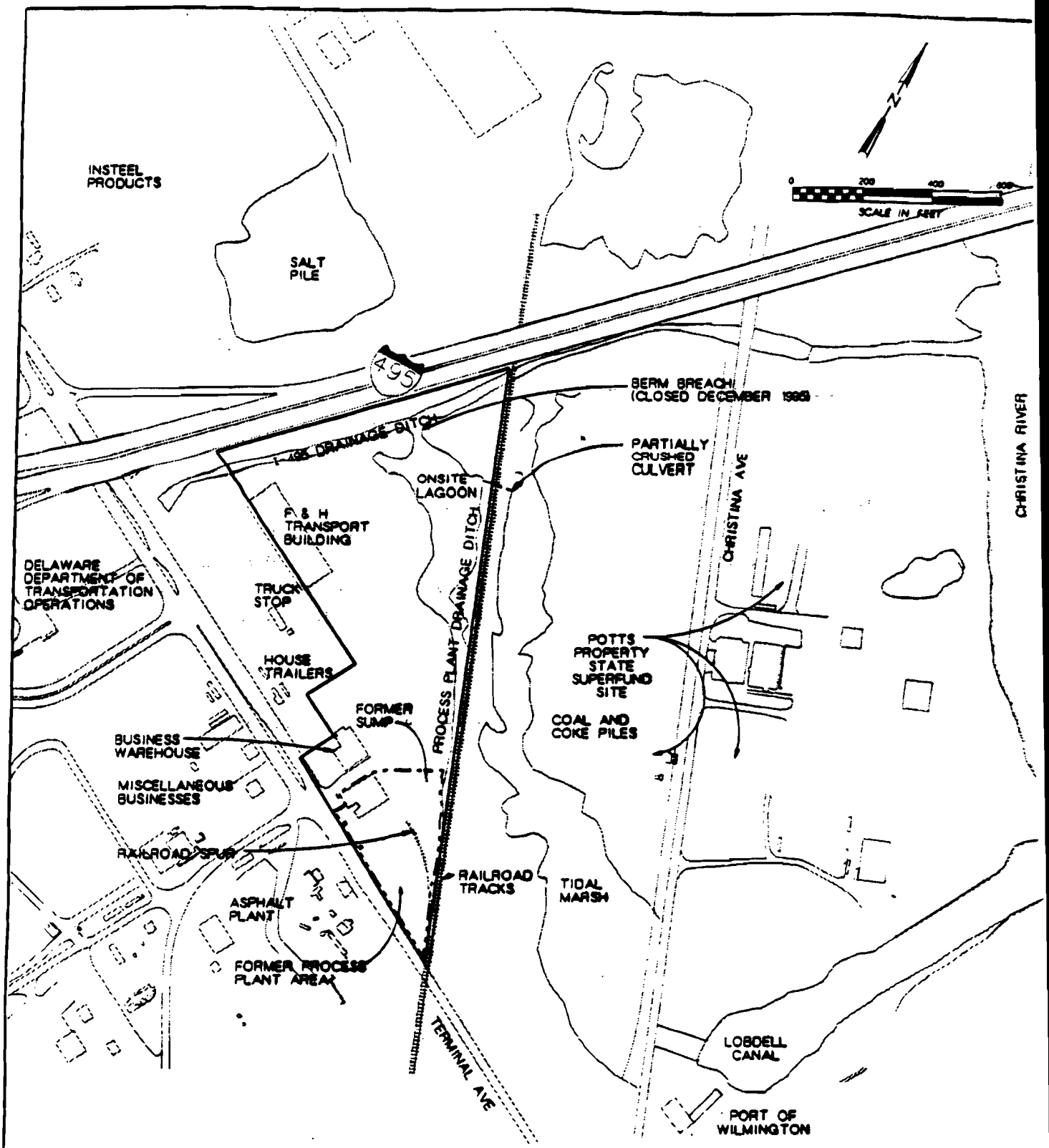
Source: USGS 7.5 minute Quadrangle Map (Wilmington South)

0 1000 2000

Scale in Feet

Figure 1
GENERAL LOCATION
Halby Chemical Site



LEGEND

HALBY CHEMICAL SITE

FORMER PROCESS PLANT AREA BOUNDARY

Figure 2
SITE LOCATION
Halby Chemical Site

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II. SITE HISTORY AND ENFORCEMENT ACTIVITY

The Halby Chemical plant was constructed at the southeastern portion of the property in the late 1940s. Specialty chemicals, primarily sulfur compounds, were processed in the chemical manufacturing plant from 1948 to 1980. From 1948 to 1964, production wastewater and cooling water were disposed of by discharge into the unlined on-Site lagoon. The lagoon drained into the adjacent tidal marsh through culvert(s) beneath the railroad tracks. The tidal marsh drained to the Christina River through the Lobdell Canal.

Between 1964 and 1972, only cooling water and accidental spillage conveyed by uncontrolled storm water or flow from the floor drains within the chemical production plant was reported to have entered the lagoon. During this period, production wastes were reportedly discharged into the sewer lines. After 1972, however, production wastewater was combined with the cooling water and storm water runoff, treated, and again discharged into the lagoon.

Through the mid-1970's the lagoon was approximately 6 acres, more than thrice its current size, extending west to a point near the back edge of the F&H Transport building which was not constructed until 1988. Aerial photos indicate that fill material was placed in the lagoon during the period between 1979 and 1982, reducing the size of the lagoon to approximately 1.8 acres. The lagoon presently receives runoff from the railroad tracks and the Site.

The chemical production facility operating as Halby Chemical closed in 1977 and the property was sold to Brandywine Chemical Company ("BCC"). BCC reportedly produced a few batches of specialty chemicals between 1978 and 1980. BCC's business operations were limited to short-term storage of chemicals in the on-Site tank farm from 1981 through 1995, when BCC stopped handling chemicals.

In 1984, EPA conducted an inspection of the Halby Chemical Site and in 1985 assigned a Hazard Ranking Score of 30.90. The Site was subsequently proposed for the National Priorities List ("NPL") in September 1985 and was finalized on the NPL on June 10, 1986.

In April 1986, EPA issued Special Notice Letters to the identified Potentially Responsible Parties ("PRPs") inviting them to perform a Remedial Investigation and Feasibility Study ("RI/FS"). The PRPs declined to conduct the RI/FS.

In June 1991, EPA completed a Fund-lead RI/FS for a portion of the Site and issued a Record of Decision ("ROD") for the first operable unit ("OU-1"). The OU-1 ROD selected a remedial alternative for soil contamination inside the former process plant area but deferred selection of appropriate remedial measures for contaminated ground water, soil outside the former process plant, and sediment in the on-Site lagoon and adjacent tidal marsh. The OU-1 ROD documented that surface soil within the process plant area presents an unacceptable potential health threat to Site workers through inadvertent breathing of dust and eating small amounts of contaminated soil. The OU-1 ROD called for stabilization of the top six inches of contaminated soil within the

3-acre former process plant compound, to be followed by paving the area with asphalt and implementing deed restrictions.

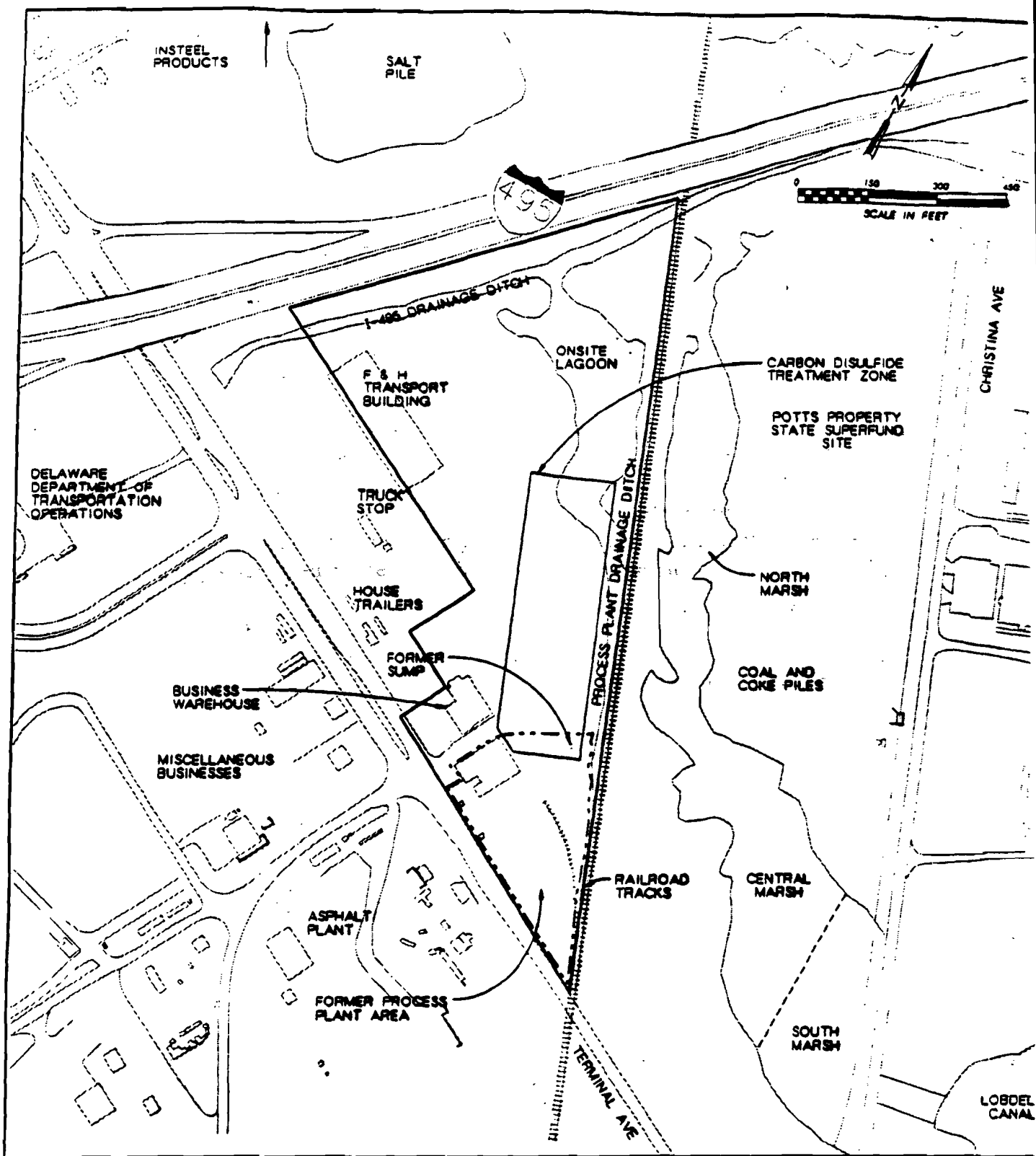
In August 1991, EPA issued Special Notice Letters to the identified Potentially Responsible Parties inviting them to design and implement the remedy selected in the OU-1 ROD. Under an April 9, 1992 Consent Decree Witco Corporation ("Witco") agreed to perform the remedial design and remedial action for the OU-1 ROD, requiring remedial actions in the former process plant area. At the time, BCC was operating a chemical distribution business on the former process plant parcel. As Witco was performing remedial design activities, BCC announced its decision to cease its chemical operations at the facility. Witco's remedial design was suspended to consider appropriate remedy modifications.

On February 3, 1995, EPA completed a Removal Site Assessment focusing on the portions of the former chemical production facility and tank farm which were not being utilized by BCC and were not properly decontaminated or maintained. On February 22, 1995 EPA issued an Action Memorandum documenting removal assessment findings and immediate actions planned to abate the immediate and significant threat posed by the presence of various hazardous substances located in numerous tanks, process lines, reaction vessels, sumps and drains, drums, pressurized cylinders and other containers. On March 6, 1995, a notice was sent informing Witco of potential liability related to necessary removal response actions.

Between February and July 1995 EPA completed the removal activities identified in the Action Memorandum to mitigate the immediate threat posed by improperly stored chemicals in the former process plant area. Buildings and above-ground storage tanks within the former chemical process plant area were dismantled and disposed of off-Site, leaving a warehouse within the fence. EPA addressed the contents of an estimated 600 small containers and 13 pressurized cylinders found in the abandoned laboratory area; an estimated 200 drums and 50 tanks found in the warehouse area, chemical processing area, and tank farm; and approximately 1,000 small containers found haphazardly mixed with shallow soil near a concrete sump in the northwest corner of the former process plant area. Chemicals in these containers and vessels including, but not limited to, carbon disulfide and ammonium thiocyanate were transported off-Site for safe disposal.

During completion of final removal activities planned in the February 22, 1995 Action Memorandum, EPA identified an area of high carbon disulfide contamination extending from the point that waste water had been discharged from the chemical production facility to the lagoon (see Figure 3). On July 6, 1995, a second Action Memorandum was issued documenting EPA's determination that the carbon disulfide may pose an imminent and substantial endangerment to human health or the environment and outlining actions to be taken to minimize the threat.

On June 30, 1995, Notice of Potential Liability was sent re-confirming Witco's potential liability and formally notifying Witco of additional removal activities to be taken at the Site.



LEGEND

HALBY CHEMICAL SITE

FORMER PROCESS PLANT AREA BOUNDARY

Figure 3
SITE FEATURES
Halby Chemical Site

CH2MHILL

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On July 20, 1995, EPA issued a Unilateral Administrative Order for Removal Action EPA Docket No. III-95-55-DC ("Removal Order") to Witco. Pursuant to the Removal Order, Witco successfully implemented mitigative measures including: installing a security fence around the carbon disulfide contamination; constructing a berm to prevent the migration of contaminants from the on-Site lagoon to the Christina River; and completing a thorough investigation delineating the extent of carbon disulfide contamination.

The investigation performed by Witco confirmed a large mass of carbon disulfide located within an area of less than 2 acres. The investigation indicated that the majority of the carbon disulfide mass was located in the uppermost 12 feet of soil due to the presence of a naturally occurring clay layer. Witco performed a series of laboratory and pilot-scale treatability studies which led to the development of an effective method to remove carbon disulfide from surface and subsurface soil to a depth of 12 feet. In January 1998, Witco successfully completed a treatment program which reduced the average concentration of carbon disulfide in soil to less than the performance goal of 1,010 mg/kg. The innovative treatment program utilized *in situ* chemical oxidation technology to degrade the carbon disulfide to carbon dioxide and sulfate salts, environmentally harmless compounds. A crane-mounted 6-feet-diameter single auger was used to mix sodium percarbonate with the contaminated soils. Soils within the carbon disulfide treatment zone were solidified with cement to a depth of 4-6 feet subsequent to chemical oxidation.

In July 1997, EPA completed the RI/FS for operable unit two (OU-2). The Remedial Investigation for OU-2, including the Human Health Baseline Risk Assessment and the Ecological Risk Assessment, was based on field data collected during the OU-1 investigation and augmented with additional data collected between 1993 and 1995. Based on these documents, as well as information gathered during the carbon disulfide removal action, a Feasibility Study describing the remedial action objectives and comparing cleanup alternatives for OU-2 was completed in July 1997. These reports are included in the Administrative Record and summarized in this Record of Decision for OU-2.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

EPA and the Delaware Department of Natural Resources and Environmental Control ("DNREC") have kept area businesses and nearby residents informed of Site activities through citizen interviews, issuance of Fact Sheets providing information on upcoming events and meetings with citizens and local officials. EPA issued Fact Sheets in December 1996 and April 1997 discussing the Superfund process and removal actions planned by EPA to address conditions at the Site which EPA determined posed an immediate risk to human health while Site-wide long-term remedial actions were under consideration.

Pursuant to CERCLA § 113(k)(2)(B)(I)-(v), EPA released for public comment the final RI/FS reports and the Proposed Remedial Action Plan ("Proposed Plan") setting forth EPA's preferred alternative for the Halby Chemical Site on July 30, 1997. EPA made these documents available

to the public in the Administrative Record located at the EPA Region III offices in Philadelphia, PA, and at the Wilmington Institute Library in Wilmington Delaware. The notice of availability of these documents was published in *The Wilmington News Journal* on July 30, 1997. A public comment period was held from July 30, 1997 to September 29, 1997. In August 1997 EPA issued a Fact Sheet announcing the Proposed Plan and date for the public meeting. The August 1997 Fact Sheet discussed EPA's Preferred Alternative, as well as other alternatives evaluated by EPA, and solicited comments from all interested parties. In addition, EPA conducted a public meeting on August 18, 1997. At this meeting, EPA and DNREC representatives answered questions about conditions at the Site and the remedial alternatives under consideration.

The responses to comments received during the public comment period are included in the Responsiveness Summary which is part of this OU-2 ROD.

This decision document presents the selected remedial action for the Halby Chemical Site, New Castle County, Delaware, chosen in accordance with the Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA"), as amended by the Superfund Amendments and Reauthorization Act ("SARA"), 42 U.S.C. §§9601 et seq. and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan ("NCP"), 40 C.F.R. Part 300. The selection of the remedial action for this Site is based on the Administrative Record.

IV. SCOPE AND ROLE OF THE RESPONSE ACTION

The Selected Remedy included in this Record of Decision is intended to be the final response action for the Halby Chemical Site. The primary objective of the OU-2 RI/FS was to develop a remedy to reduce or eliminate the potential for human or ecological exposure to unacceptable risks associated with contaminated soil outside the former process plant area, sediment in the on-Site lagoon and adjacent tidal marsh, and ground water at the Halby Chemical Site. However, because the soils addressed previously under OU-1 are similar in character to the OU-2 soils and both areas will be used for industrial purposes, the scope of the Proposed Plan issued in July 1997 was expanded to include the entire Site. The OU-2 Record of Decision will supersede the OU-1 Record of Decision. Therefore, the Selected Remedy described in this Record of Decision will comprehensively address the threats posed by the release of hazardous substances from the Site. This Record of Decision addresses unacceptable risks and hazards presented to both human health and the environment. Specifically, the Selected Remedy addresses human health risks presented by: (1) arsenic-contaminated soil on the Site and adjacent residential parcel; and, (2) sediment located in the on-Site lagoon and adjacent tidal marsh. The Selected Remedy addresses unacceptable risks presented to wildlife and aquatic organisms by sediment located in the on-Site lagoon and adjacent tidal marsh. In addition, the Selected Remedy includes necessary action to prevent the potential for future exposure to contaminated ground water beneath the Site.

V. SUMMARY OF SITE CHARACTERISTICS AND EXTENT OF CONTAMINATION

A. Site Characteristics

1. Topography

The Halby Chemical Site is in the Coastal Plain Physiographic Province, approximately 1.25 miles south of the Fall Line. Topographically, the Site is generally flat but slopes down very gently northeastward with elevations ranging from 5-15 feet above Mean Sea Level ("MSL").

2. Surface Hydrology

Surface water is present in the on-Site lagoon, the I-495 drainage ditch and the tidal marsh east of the railroad tracks. Storm water from the Site drains to the on-Site lagoon. Through 1983 the on-Site lagoon was hydraulically connected to the tidal marsh by a culvert(s) beneath the railroad tracks. In 1983 the culvert became obstructed with sediment. A berm separating the lagoon and the I-495 drainage ditch was breached to allow surface water to drain from the lagoon to the Christina River. In December 1995 the berm was re-established and the lagoon is now isolated from off-Site water bodies.

Surface water in the tidal marsh and the I-495 drainage ditch is tidally influenced; surface water in the on-Site lagoon was tidally influenced until the breach in the berm was closed. Surface water elevations vary by approximately 2-3 feet under average tidal conditions.

Several investigations, including Thermal Infrared imagery, were conducted to determine the relationship between the surface water in the lagoon and tidal marsh and the shallow ground water at the Site. The infrared imaging and other temperature related investigations found that the hydraulic communication is not uniform across the Site; however there appears to be localized areas of ground water discharge to the tidal marsh most of the time but that the discharge may be greatly slowed, stopped or even reversed briefly at high tide. The U.S. Geological Survey estimates that 7.4 inches of water per year discharges to the tidal marsh.

3. Hydrogeology

The Site is located within the Coastal Plain Physiographic Province which consists of an eastward thickening wedge of unconsolidated interbedded sand, silt and clay layers with lenses of sand, silt or clay sediment. There are three water-bearing formations, or aquifers, beneath the Site. The water table is encountered between 5 and 15 feet below the ground surface. The Columbia formation and fill material comprise the surficial aquifer which is approximately 20 to 30 feet thick across the Site. Below the surficial aquifer is an upper sand of the Potomac Aquifer which extends 60-75 feet below ground surface. Between these two aquifers, there is a 5-25 feet thick silt layer which reduces vertical water flow between them; however, this silt layer is absent beyond the Site toward the Christina River. The ground water in both the Columbia and Upper

Potomac flows to the northeast, under the adjacent Potts Property State Superfund Site and toward the Christina River. The deepest unconsolidated aquifer at this Site is a lower sand of the Potomac Aquifer approximately 80-100 feet below ground surface. At the Site, the lower sand aquifer is confined with a 20-30 feet clay layer between it and the upper sand of the Potomac Aquifer. This clay layer appears to have prevented the movement of Site-related contaminants found in the shallower aquifers through to the lower sand of the Potomac Aquifer. Ground water in the lower sand aquifer flows to the south. The United States Geological Survey determined that if any contamination reached the lower Potomac, it would take at least 120 years to reach the nearest well in the Collins Park well field that is 9,200 feet from the Halby Chemical site.

The Columbia and Upper Potomac Aquifers have been chemically degraded with Site-related chemicals. A summary of the findings is provided in Section B.4 Ground Water, below. There are no drinking water wells withdrawing ground water from either the Columbia or Upper Potomac Aquifers within 2 miles downgradient of the Site.

Although ground water passing beneath the Halby Chemical and Potts Sites most likely discharges to the river adjacent to the shore, some of the ground water may flow beneath the river. Additional data is being collected under the direction of DNREC pursuant to the on-going Remedial Investigation of the adjacent Potts Property State Superfund Site, including an evaluation of ground water and contaminant flow at the Christina River interface. In the event that the Potts Site investigation determines that contaminated ground water naturally discharging to the Christina River presents an unacceptable risk to human health or the environment DNREC will evaluate the options for protecting the river and propose a Plan of Remedial Action.

4. Demography and Land Use

The Site is located approximately 1,200 feet from the Port of Wilmington. The Site and its vicinity are zoned for industrial use. The Site and surrounding properties have been primarily used for heavy industry. Several small businesses are presently operating on or adjacent to the Site, including: a truck tire repair shop; an overseas auto shipping company; a wooden pallet operation; a security firm; and, a trucking company. Surrounding land use includes an asphalt plant to the west, Forbes Steel Company to the north, large piles of petroleum coke located on the Potts Property State Superfund Site to the east and the Port of Wilmington to the south.

Most of the developed areas between Terminal Avenue and the Christina River were claimed from wetlands, which dominated the area in the early 1900s. Interstate 495 was constructed during the 1960s.

Two small residential communities are within 1 mile of the Site. Adjacent to the Site is a parcel supporting two trailer residences, each with one resident. This parcel was utilized for residential purposes prior to industrial land use designation by New Castle County and has therefore non-conforming legal status. The entire city of Wilmington is within 3 miles of the Site and has an approximate population of 71,500. The Wilmington City limit passes through the Site.

5. General Site Geology

The Piedmont Uplands Section of the Piedmont Physiographic Province and the Coastal Plain Physiographic Province are present in New Castle County, Delaware. These two provinces are separated by a boundary designated as the Fall Line, which is situated approximately 1.25 miles to the north of the Site. The Piedmont Province is located north of the Fall Line, while deposits of the Coastal Plain Province are south of this boundary. The Site is located within the Coastal Plain Physiographic Province, approximately 1.25 miles south of the Fall Line. Based on reports published by the Delaware Geological Survey, the depth to weathered bedrock at the Site is approximately 100-150 feet.

In general, the lithology beneath the Site consists of unconsolidated sands, gravels, silts, and clays of the Columbia and Potomac Formations and recent sediments, and weathered bedrock of the Wilmington Complex. The Cretaceous Age Potomac Formation is the basal sedimentary unit of the Coastal Plain sediments. The Potomac Formation is unconformably overlain by the Pleistocene Age Columbia Formation which is exposed at the surface except where overlain by the recent sediments deposited by the Christina River or fill material.

6. Ecology

In the late 19th century, most of the land that now supports the Halby Chemical Site was an intertidal freshwater wetland. In the early 1900's, all but approximately 6 acres of wetland area, the on-Site lagoon, were filled in. During active chemical plant operations the 6-acre lagoon was utilized for the disposal of aqueous wastes and storm water runoff. In the early 1980's more fill material was placed in the lagoon thereby reducing its size to approximately 1.8 acres. The majority of the area encompassed by the Halby Chemical Site has been disturbed by current and past heavy industrial use. In addition, land use surrounding the Site is also industrial.

The ecological characterization performed during Remedial Investigation activities identified likely receptors of hazardous substances, defined pathways of assimilation or transport of contaminants, and suggested opportunities and constraints for remedying the Site from an ecological perspective. A Site survey identified major habitats including: industrially developed and disturbed undeveloped land; and lagoon and I-495 drainage ditch waterways with associated wetlands.

The developed parts of the Site are the largest single component by size. Warehouses, parking areas, the former process plant area and impervious and semi-pervious surfaces occur throughout the area as asphalt or gravel parking lots. Only species that have adapted to urban environments are likely to occur in these areas. The proximity to wetlands and the Christina River make it possible for transient species to pass through the developed portions of the Site on an infrequent basis.

Small areas of disturbed undeveloped upland property occur beneath the high tension electrical towers and cables. The largest area is approximately one acre in the northeastern corner bounded

by I-495, the railroad tracks and the lagoon. The vegetative community on the disturbed undeveloped land is dominated by species adapted to disturbed urban environments and upland soil. Plant species including winged sumac, sassafras, crab apple, black cherry and *Phragmites sp.* were found growing on the undeveloped land. These species typically are found growing in poor soil and are early colonizers after ground disturbances.

Until recently the on-Site lagoon was a tidal freshwater system having a tidal range of approximately 2 to 3 feet. At low tide, much of the lagoon was exposed as mudflats; about 25 percent consisted of open water deeper than 2 feet. Of this 1.8 acres of tidal wetland/shallow water complex approximately 0.55 acres was unvegetated shallow open water habitat and approximately 0.7 acres were permanently inundated with predominantly floating vegetation. In December 1995 the outlet of the lagoon to the I-495 drainage ditch was blocked to prevent migration of contaminated lagoon sediments off-Site. The lagoon at one time was connected to the tidal marsh east of the Site via one or more pipes leading under the railroad tracks. There is a total of approximately 5.2 acres of tidal marsh providing aquatic habitat east of the railroad tracks on the Potts Site. Of this area approximately 0.4 acres are unvegetated open water habitat and 2.2 acres are permanently inundated with predominantly floating vegetaion.

When the lagoon was hydraulically connected to the Christina River the vegetation and open water in the lagoon supported a population of fish. In November 1994, eight species of finfish, including american eel, mummichog, and redear sunfish were collected from the lagoon. All of the fish collected are brackish-to-freshwater species common in the estuaries of the mid-Atlantic states. The status of the current population is unknown as the lagoon is no longer connected to the Christina River. The open water and vegetation in and around the lagoon provide habitat for a number of other species, including wading birds and waterfowl, reptiles, amphibians, insects and mammals.

In 1988, the U.S. Fish and Wildlife Service identified wetland areas on and in the vicinity of the Site. The lagoon and I-495 drainage ditch are characterized as estuarine intertidal, emergent, narrow-leaved regularly flooded wetlands. The I-495 drainage ditch is tidally influenced and also conveys storm water runoff from surrounding properties and the I-495 highway. A second wetland area was located in the carbon disulfide treatment zone south of the lagoon. This vegetated wetland had been badly degraded due to the presence of high concentrations of carbon disulfide and approximately 0.1 acre was filled in during the recent treatment program. Prior to its destruction this wetland was identified as a palustrine emergent seasonally flooded wetland.

Vegetation on the Site is dominated by invasive wetland species including common reed (*Phragmites australis*) and purple loosestrife (*Lythrum salicaria*). The lagoon includes a band of emergent wetland species around the perimeter of the water, surrounded by a stand of common reed.

B. Nature and Extent of Contamination

1. Soil

Surface Soil Contamination (0-2 feet): More than one hundred surface soil samples have been collected within the former process plant area, the process plant ditch area, the northwestern part of the Site and the adjacent residential parcel. The following findings were noted:

- Elevated arsenic concentrations were detected in surface soil located in the former process plant area at concentrations up to 1,410 parts per million (ppm) and the former process plant drainage ditch area at concentrations up to 1,010 ppm. Arsenic was detected at up to 80 ppm in the backyard area of the adjacent residential parcel. The northwestern part of the property (between F&H Transport's office/warehouse and the lagoon) has been covered with slag to create a stable base for truck traffic. Therefore, arsenic contaminated soils are not exposed at the surface. Arsenic is the primary contaminant in surface soil at the Halby Chemical Site.

- Other contaminants detected at elevated levels in surface soil include:
  - beryllium (116 ppm); and
  - manganese (26,100 ppm)

Subsurface Soil Contamination (2-12 feet): Several hundred subsurface soil samples have been collected across the Site at more than 100 locations. A summary of the results is given below:

- Elevated arsenic concentrations were detected in subsurface soil located in the former process plant area at concentrations up to 1,300 ppm, the former process plant drainage ditch area at concentrations up to 11,900 ppm and the northwestern part of the Site at concentrations up to 2,500 ppm. A sample collected from a soil pile excavated from the northwestern corner of the former process plant area contained 30,900 ppm arsenic. Arsenic is the primary contaminant in subsurface soil.

- Other contaminants detected at elevated levels include antimony (3,810 ppm), lead (3,590 ppm) and copper (24,300 ppm).

Carbon disulfide had been detected in surface soil at a concentration of up to 59,000 ppm and subsurface soil as high as 160,000 ppm. The area of high carbon disulfide contamination in soil was limited to approximately 1-2 acres, extending from the point that aqueous waste had been discharged from the chemical production facility to the lagoon. In January 1998, treatment of carbon disulfide contaminated soil was completed to a depth of 12 feet below the ground surface. The concentration of carbon disulfide in soil was reduced to less than the performance goal of 1,010 ppm. After the treatment process was completed, the uppermost 4-6 feet of soil within the carbon disulfide treatment zone was stabilized with concrete.

Elevated levels of metals in surface and subsurface soil may originate from multiple sources. Known production of arsenic-containing chemical products at the Halby Chemical facility likely resulted in significant arsenic contamination of surface and subsurface soils. Observations documented during monitoring well installation indicate that 6-16 feet of soil has been deposited over the Site which was historically a wetland. Soil used to backfill the property may have contained high levels of various metals prior to its deposition. Although high levels of arsenic and other metals occur in all areas of the property investigated, the concentrations are highly variable with discontiguous local areas of high metal concentration.

2. Sediment

Lagoon and Tidal Marsh Sediment Contamination: Sediment samples were collected from the on-Site lagoon, the adjacent tidal marsh, the I-495 drainage ditch and the Christina River. Sediment collected from both on- and off-Site locations demonstrate poor quality due to chemical degradation of the aquatic ecological system (see Figure 4).

- Sediment in the on-Site lagoon and the tidal marsh demonstrate substantial Site-related degradation; the north and central portion of the tidal marsh is more degraded than the southern portion. Inorganic compounds and metals which were identified in both the on-Site lagoon and tidal marsh sediment at concentrations above levels known to be protective of aquatic life include ammonia, arsenic, cadmium, cobalt, copper, lead, mercury, silver, thiocyanate and zinc. Nickel and vanadium were also found at elevated levels in the tidal marsh sediment. Concentrations of arsenic, copper, and thiocyanate in the on-Site lagoon and tidal marsh sediment are more than 100 times higher than levels known to be safe for aquatic organisms. Zinc is also present at this level in the on-Site lagoon. Volatile organic contaminants ("VOCs") detected at levels of potential ecological concern include 2-butanone and carbon disulfide in both the on-Site lagoon and tidal marsh. Semi-volatile organic compounds ("SVOCs") were detected at elevated levels; however, SVOCs concentrations were similar to the levels identified in the Christina River and are not considered to be Site-related contaminants.

  Arsenic was the only contaminant detected in on-Site lagoon and tidal marsh sediments at a level of potential concern to human health.

- The following metals were identified in the southern marsh sediment at concentrations six times above levels known to be protective of aquatic life and at least twice the concentration found in sediment collected from the Christina River: arsenic, cadmium, cobalt, copper, and zinc. Mercury and nickel are well above concentrations known to be protective. Mercury concentrations are highest in sediments from the on-Site lagoon and decline as sample locations move through the tidal marsh toward the Christina River. Nickel concentrations are highest in the northern/central tidal marsh sediments, suggesting the Potts Site as another probable source area. Semi-volatile organic

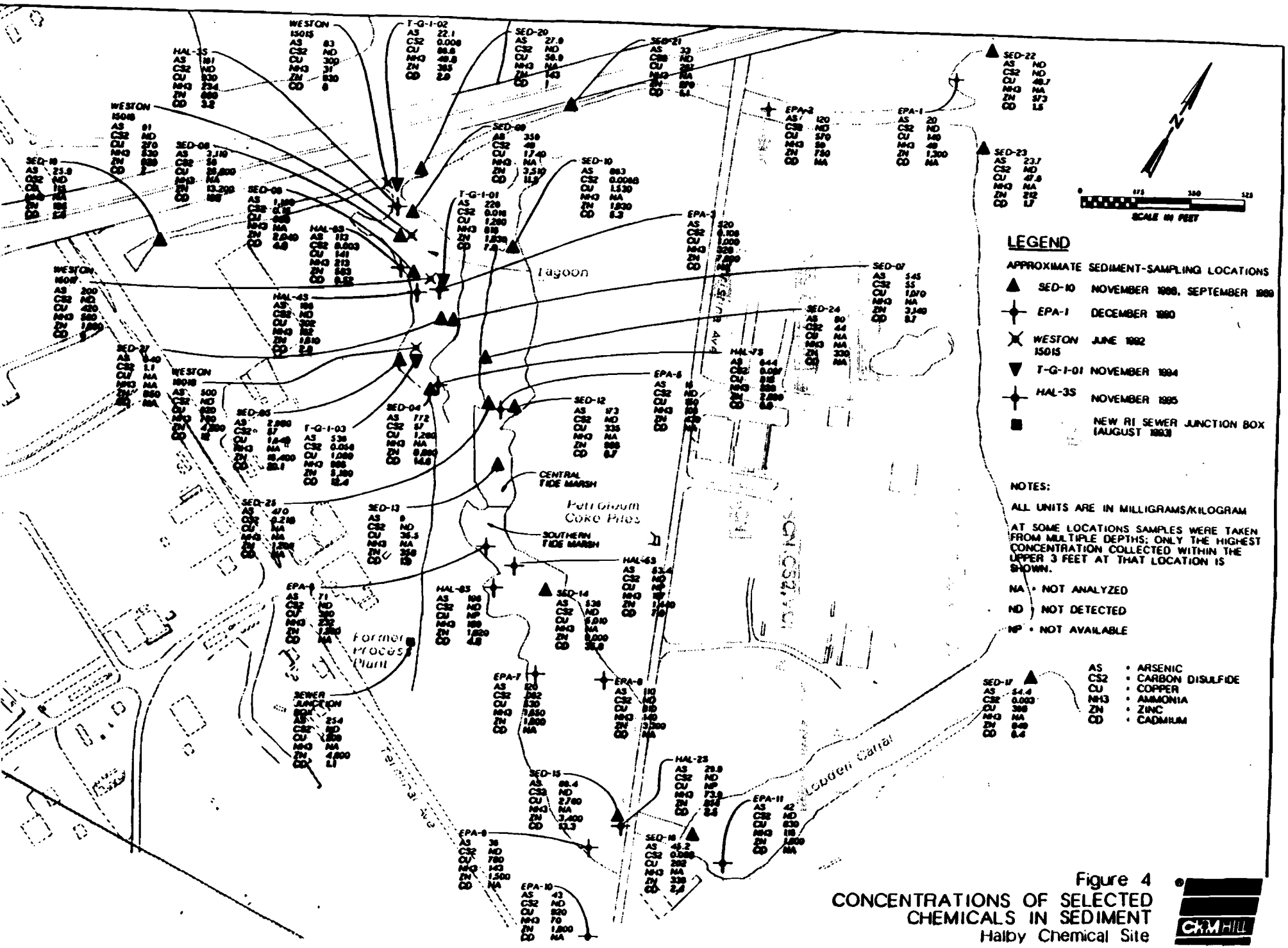


Figure 4
CONCENTRATIONS OF SELECTED CHEMICALS IN SEDIMENT
Halby Chemical Site

compounds were detected at concentrations similar to the levels identified in the Christina River and are not considered to be Site-related contaminants.

Arsenic was the only contaminant detected in southern marsh sediment at a level of potential concern to human health.

- Arsenic and copper were identified in the I-495 drainage ditch sediment at concentrations thirteen times above levels known to be safe for aquatic life and at least four times the concentration found in sediment collected from the Christina River.

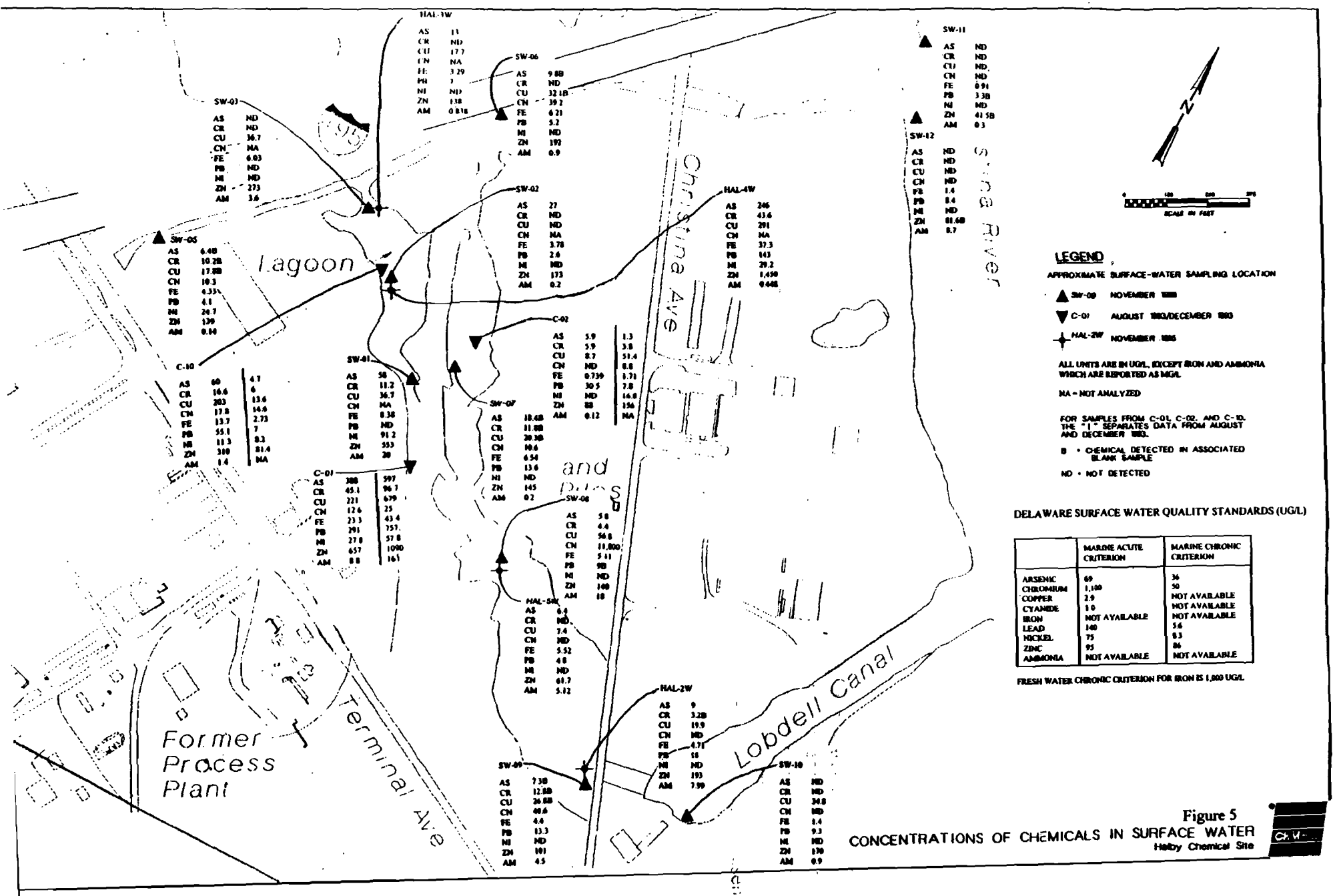
- Sediment collected from the Christina River contained levels of several SVOCs including benzo(a)anthracene, benzo(a)pyrene, benzo(a)fluoranthene, chrysene, fluoranthene, phenanthrene and pyrene at levels ten times greater than levels known to be protective of aquatic life. Based on the distribution of SVOCs, they are not considered Site-related compounds. Copper, lead and zinc concentrations in river sediments were also elevated with respect to the conservative ecological benchmarks used to screen contaminants of potential concern. Copper and zinc concentrations are much higher in the on-Site lagoon sediment and decline as sample locations move through the tidal marsh toward the Christina River. Lead concentrations are highest in the northern/central tidal marsh sediments, suggesting the Potts Site as another probable source area.

3. Surface Water

Surface Water Contamination: Surface water samples were collected from the on-Site lagoon, the I-495 drainage ditch, the adjacent tidal marsh and the Christina River just upgradient of its confluence with the I-495 drainage ditch (see Figure 5). A berm has been constructed to isolate the lagoon from the I-495 drainage ditch and thereby reduce the migration of Site-related contaminants to the river. The river sample from upstream of the Site can give some indication of background concentrations. Since the river is tidally influenced, there is no absolute "up stream" sample.

- The surface water quality in the on-Site lagoon is generally degraded with concentrations of several metals, including arsenic, chromium, copper, iron, lead, nickel, cyanide and zinc exceeding Delaware water quality standards for protection of aquatic life. In addition, concentrations of ammonia and carbon disulfide were as high as 20,000 and 4,000 parts per billion (ppb), respectively.

- The surface water in the tidal marsh contained levels of cyanide, iron and zinc at concentrations exceeding Delaware water quality standards for protection of aquatic life. In addition, the concentration of ammonia was as high as 18,000 ppb.



DELAWARE SURFACE WATER QUALITY STANDARDS (UG/L)

	MARINE ACUTE CRITERION	MARINE CHRONIC CRITERION
ARSENIC	69	36
CHROMIUM	1,100	50
COPPER	2.9	NOT AVAILABLE
CYANIDE	1.0	NOT AVAILABLE
IRON	NOT AVAILABLE	NOT AVAILABLE
LEAD	140	5.6
NICKEL	75	8.3
ZINC	95	86
AMMONIA	NOT AVAILABLE	NOT AVAILABLE

FRESH WATER CHRONIC CRITERION FOR IRON IS 1,000 UG/L

Figure 5

CONCENTRATIONS OF CHEMICALS IN SURFACE WATER

Helby Chemical Site

- The surface water from the I-495 drainage ditch contained cyanide at a concentration exceeding Delaware water quality standards for protection of aquatic life. In addition, the concentration of manganese was as high as 2,160 ppb.

Concentrations of metals in the Christina River surface water are much lower than concentrations in the lagoon and tidal marsh. There are no current point source discharges to the lagoon or tidal marsh. Elevated concentrations are likely caused by erosion of contaminated surface soil, the continued leaching of contaminants from lagoon and tidal marsh sediment, and the natural discharge of contaminated ground water into the surface water bodies.

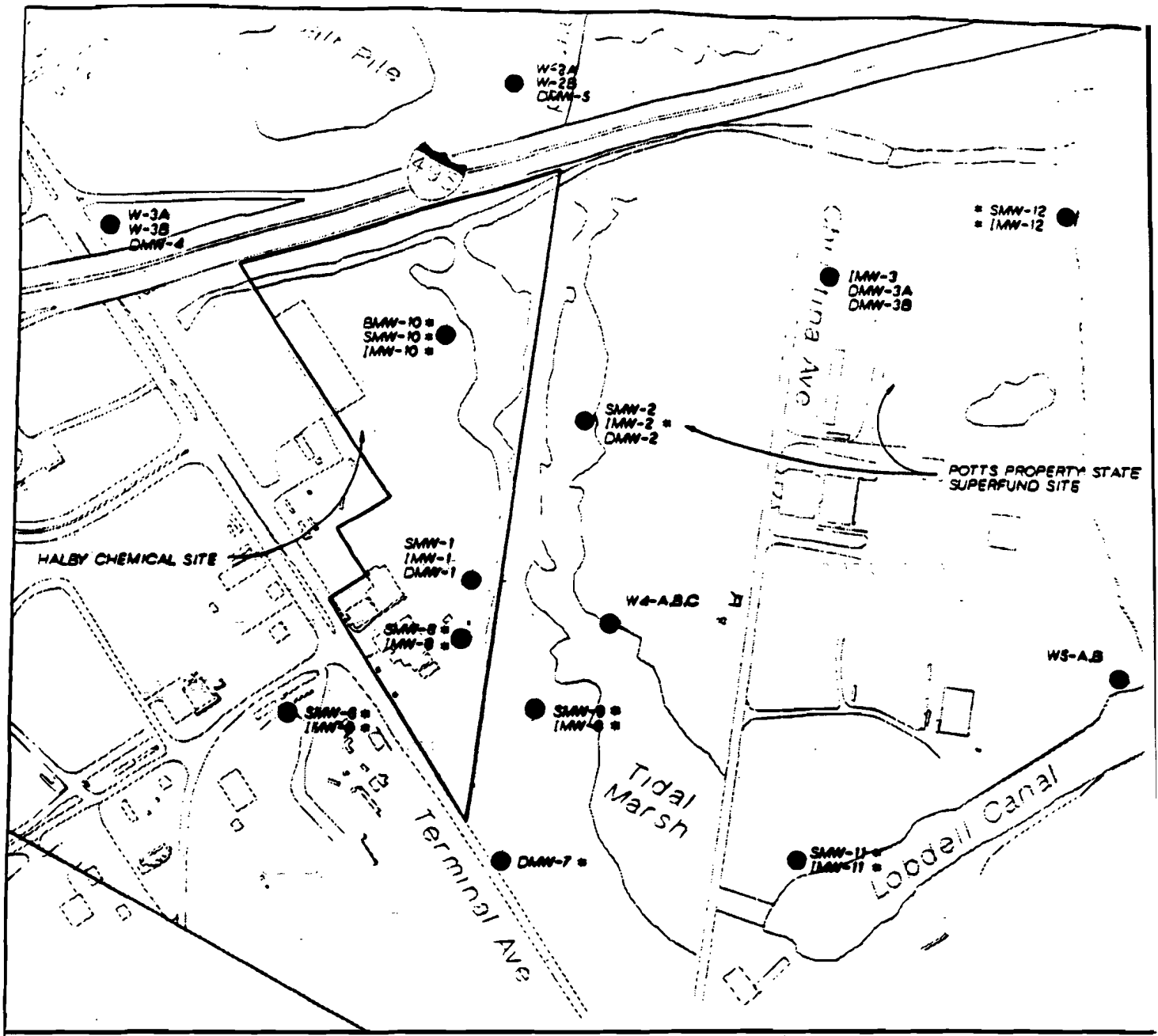
4. Ground Water

Ground water contamination: Fifteen new ground water monitoring wells were installed on or around the Site to augment the 19 monitoring wells which were sampled as part of the 1990 Remedial Investigation (see Figure 6). The wells identified as being downgradient of the Halby Chemical Site are actually placed within the Potts Property State Superfund Site.

- The primary contaminants detected in ground water in the Columbia Aquifer directly beneath the Site include arsenic (up to 535 ppb), ammonia (up to 178,000 ppb), manganese (up to 19,700 ppb), thiocyanate (up to 130,000 ppb), vinyl chloride (up to 31 ppb), trichloroethene (up to 37 ppb), tetrachloroethene (up to 25 ppb) and carbon disulfide (up to 333,000 ppb). The primary contaminants identified in the Columbia Aquifer monitoring wells located downgradient of the Site include arsenic (up to 1,400 ppb), ammonia (up to 392,000 ppb), manganese (up to 180,000 ppb), thiocyanate (up to 280,000 ppb), 1,1-dichloroethene (up to 110 ppb), toluene (up to 6,600 ppb), vinyl chloride (up to 230 ppb) and carbon disulfide (up to 210 ppb). Analyses of ground water in the Columbia Aquifer upgradient of the Site identified ammonia (up to 3,200 ppb), manganese (up to 1,140 ppb), thiocyanate (up to 5,260 ppb), and trichloroethene (up to 41 ppb). No other Site-related contaminant was identified upgradient of the Site above the detection limit. See Figure 7 for an abbreviated summary of comtaminants identifed in the Columbia Aquifer.

  In addition, iron and zinc were identified in the Columbia Aquifer located just beneath the central portion of the Site and downgradient central tidal marsh at concentrations up to 162,000 ppb and 132,000 ppb, respectively. Aquatic organisms may be adversely affected by elevated levels of iron and zinc in surface water. This is significant due to the potential for natural discharge of ground water into the overlying lagoon and tidal marsh.

- The primary contaminants detected in ground water in the Upper Potomac Aquifer directly beneath the Site include ammonia (up to 106,000 ppb), cadmium (up to 691 ppb), manganese (up to 87,000 ppb), nickel (up to 1,110 ppb), thiocyanate (up to 1,400,000 ppb), trichloroethene (up to 46 ppb), tetrachloroethene (up to 25 ppb) and carbon disulfide (up to 870 ppb). The primary contaminants identified in Upper Potomac



LEGEND

HALBY CHEMICAL SITE

SMW-1 — SHALLOW MONITORING WELL

IMW-1 — INTERMEDIATE MONITORING WELL

DMW-1 — DEEP MONITORING WELL

W4-A,B,C
A = LOWER POTOMAC WATER-BEARING UNIT
B = UPPER POTOMAC WATER-BEARING UNIT
C = COLUMBIA WATER-BEARING UNIT

NOTE: " * " INDICATES MONITORING WELLS INSTALLED DURING 1983.

N

0 200 400 600
SCALE IN FEET

Figure 6
MONITORING WELL LOCATIONS
Halby Chemical Site

CH2M HILL

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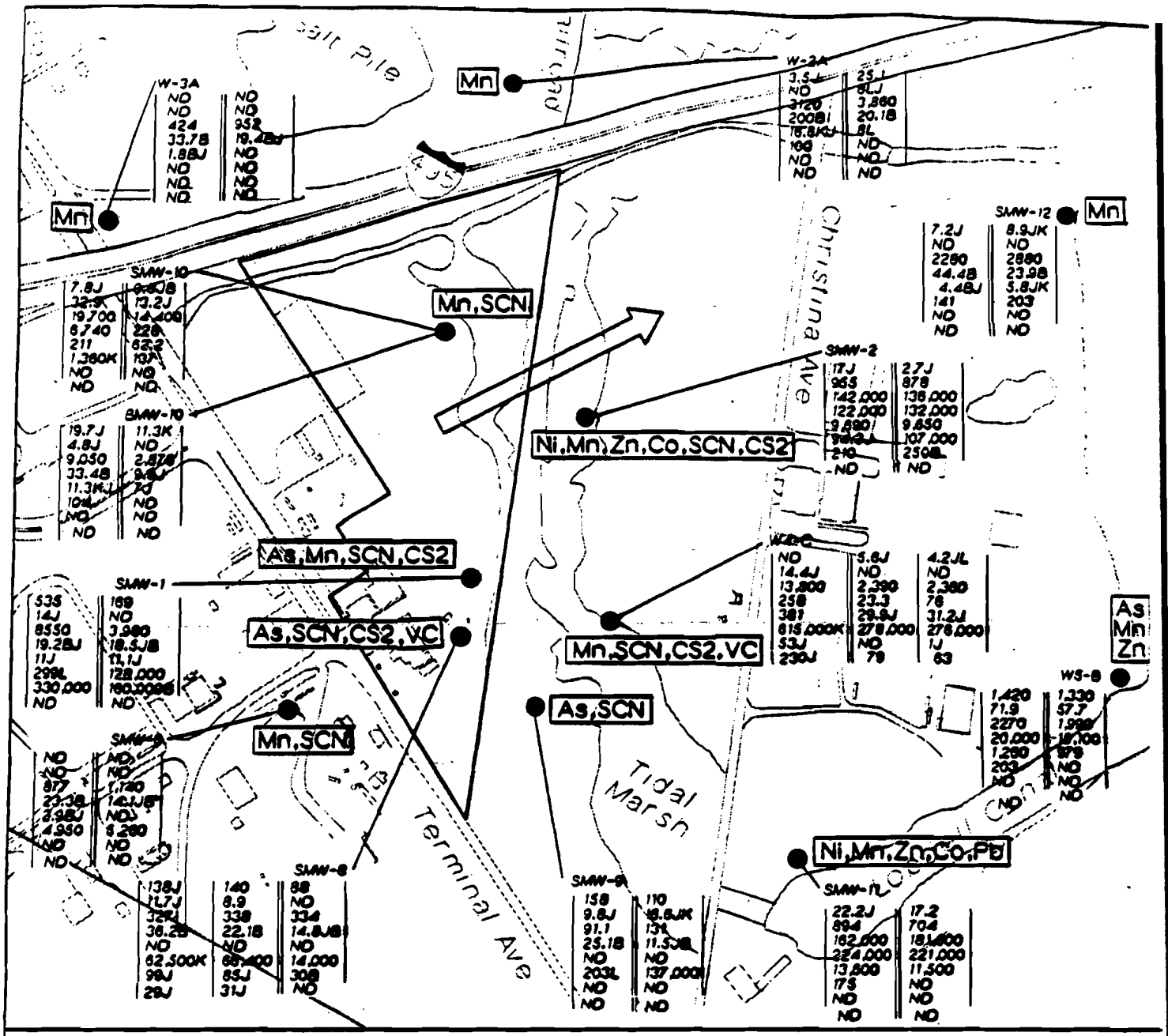

LEGEND

HALBY CHEMICAL SITE

SMW-6 MONITORING WELL LOCATION

UNITS ARE IN ug/l

ROUND 1 SAMPLING (8-93)	ROUND 2 SAMPLING (12-93)	
7.8J	0.8JB	ARSENIC
32.9	13.2	NICKEL
19,700	14,400	MANGANESE
6,740	228	ZINC
211	62.2	COBALT
1,360K	137	THIOCYANATE
ND	ND	CARBON DISULFIDE
29J	ND	VINYL CHLORIDE (VC)

Mn DENOTES SIGNIFICANTLY ELEVATED CONCENTRATION OF INDICATED CHEMICAL

APPROXIMATE DIRECTION OF GROUNDWATER FLOW

N

0 200 400 800

SCALE IN FEET

NOTE: B-INDICATES THAT CHEMICAL WAS DETECTED IN THE ASSOCIATED METHOD BLANK.
J-INDICATES THAT THE SAMPLE CONTAINS CHEMICAL AT AN ESTIMATED CONCENTRATION.
K-INDICATES CONCENTRATION IS BIASED HIGH.
L-INDICATES CONCENTRATION IS BIASED LOW.
R-INDICATES DATA WERE REJECTED DURING VALIDATION.
ND-INDICATES THAT THE CHEMICAL WAS NOT DETECTED.

TWO CONCENTRATION VALUES SEPARATED BY A " | " INDICATES A SAMPLE AND ITS DUPLICATE.

WELL BMW-10 IS SCREENED PRIMARILY IN THE BACKFILL OVERLYING THE COLUMBIA.

RBC = RISK-BASED CONCENTRATION

Figure 7
SELECTED CHEMICALS DISSOLVED IN COLUMBIA WATER-BEARING UNIT
Halby Chemical Site

CH2M HILL

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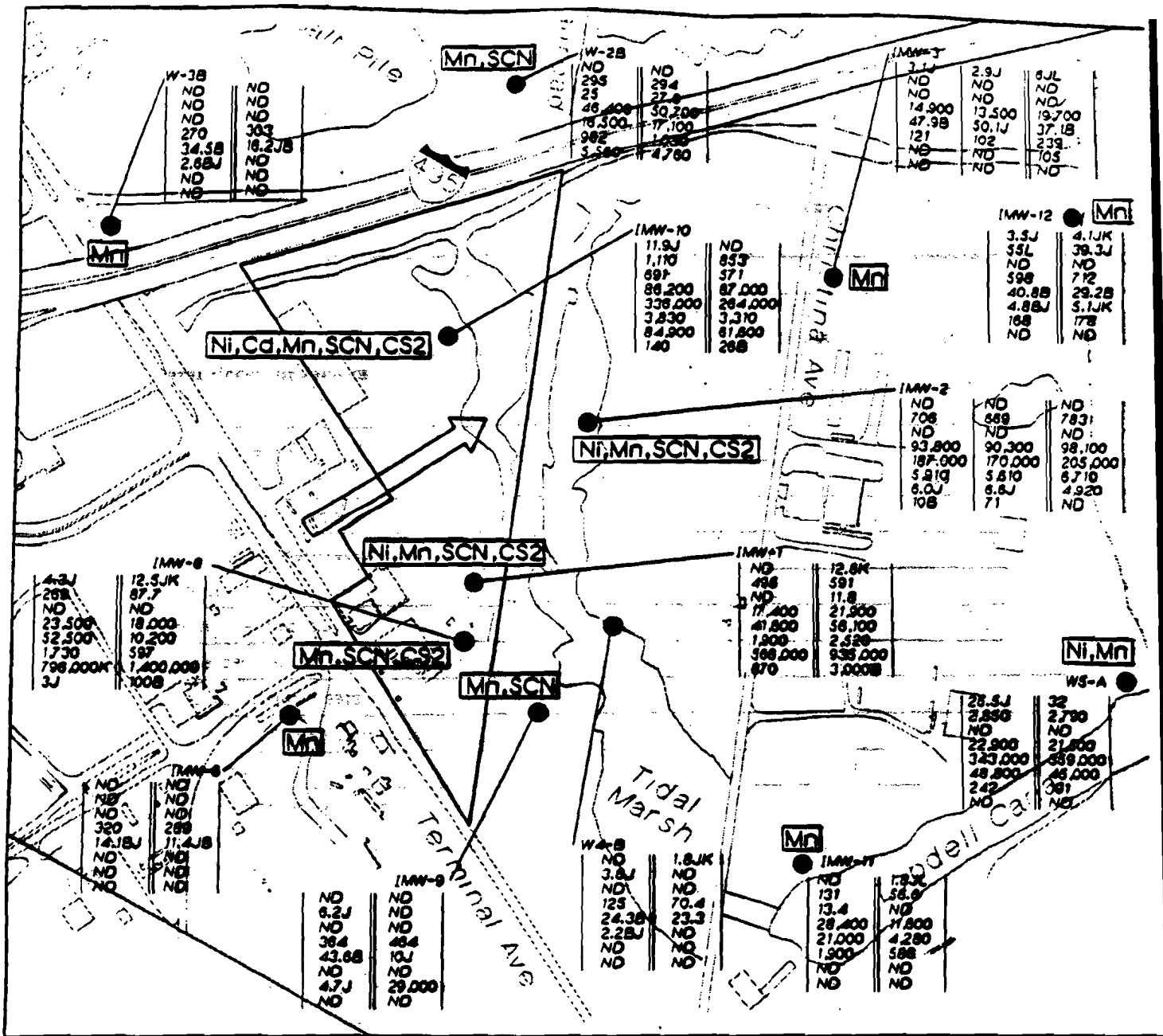

LEGEND

HALBY CHEMICAL SITE

IMW-10 MONITORING WELL LOCATION

UNITS ARE IN ug/l

ROUND 1 SAMPLING (8-93)	ROUND 2 SAMPLING (12-93)	
11.9J	ND	ARSENIC
1,100	853	NICKEL
591	571	CADMIUM
86,200	87,000	MANGANESE
336,000	264,000	ZINC
3,830	3,310	COBALT
84,900	61,600	THIOCYANATE
140	268	CARBON DISULFIDE

Mn DENOTES SIGNIFICANTLY ELEVATED CONCENTRATION OF INDICATED CHEMICAL

APPROXIMATE DIRECTION OF GROUNDWATER FLOW

N

0 200 400 600

SCALE IN FEET

NOTE: B-INDICATES THAT CHEMICAL WAS DETECTED IN THE ASSOCIATED METHOD BLANK.
J-INDICATES THAT THE SAMPLE CONTAINS CHEMICAL AT AN ESTIMATED CONCENTRATION.
K-INDICATES CONCENTRATION IS BIASED HIGH.
L-INDICATES CONCENTRATION IS BIASED LOW.
R-INDICATES DATA WERE REJECTED DURING VALIDATION.
ND-INDICATES THAT THE CHEMICAL WAS NOT DETECTED.

TWO CONCENTRATION VALUES SEPARATED BY A "|" INDICATES A SAMPLE AND ITS DUPLICATE.

RBC = RISK-BASED CONCENTRATION

Figure 8

SELECTED CHEMICALS DISSOLVED IN UPPER POTOMAC WATER-BEARING UNIT

Halby Chemical Site

CH2M HILL

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Aquifer monitoring wells located downgradient of the Site include ammonia (up to 94,000 ppb), nickel (up to 783 ppb), manganese (up to 98,000 ppb), thiocyanate (up to 29,000 ppb), and carbon disulfide (up to 71 ppb). Analyses of ground water in the Upper Potomac Aquifer upgradient of the Site identified manganese up to 320 ppb. No other Site-related contaminant was identified upgradient of the Site above the detection limit. See Figure 8 for an abbreviated summary of comtaminants identifed in the Upper Potomac Aquifer.

- The only contaminant detected at a concentration of potential concern in ground water in the Lower Potomac Aquifer directly beneath the Site is thallium (up to 2.6 ppb). Monitoring well DMW-7 is hydraulically downgradient of the Potts Property State Superfund Site, including the tidal marsh (which historically conveyed Halby Chemical's aqueous wastes to the Lobdell Canal); however, the location is not directly downgradient of the chemical production area located at the Site. No wells were screened in the Lower Potomac Aquifer directly downgradient of the Site. The ground water monitoring program will be expanded to include this area.

Dense Non-Aqueous Phase Liquids ("DNAPLs"): Carbon disulfide is nearly 1.3 times denser than water and will tend to accumulate in the deeper portions of the aquifer where it is found. A concentration of carbon disulfide found in the Columbia Aquifer at monitoring well SMW-1, located within the carbon disulfide treatment zone, exceeded 15% of its reported solubility in water. This high concentration suggests a strong likelihood that carbon disulfide is present as a DNAPL. SMW-1 was screened at an interval of 8-28 feet below the ground surface. Prior to the recent carbon disulfide treatment program, subsurface soil sampled within the former process plant drainage ditch area contained up to 160,000 ppm carbon disulfide and free phase carbon disulfide was observed within water-filled trenches created during subsurface soil sampling.

Extensive soil sampling conducted within the area referred to as the carbon disulfide treatment zone suggests that the greatest mass of carbon disulfide was located between 4-12 feet below the ground surface. As mentioned previously, during a treatment operation completed in January 1998, the contaminated subsurface soil was successfully treated to remove carbon disulfide to a depth of 12 feet. The treatment project removed a significant amount of carbon disulfide from the environment. Nevertheless, treating the contaminated subsurface soil at a depth greater than 12 feet was not practical due to technological limitations. Therefore, DNAPL will likely remain in the Columbia formation between 12 and 30 feet below the ground surface. DNAPL found in the aquifer can be a source for continued release of contamination, therefore, complicating cleanup. During the drilling of monitoring well #1, the only well installed directly within the carbon disulfide contaminated area, there was no direct visual evidence, such as staining of aquifer material, that DNAPL was present at depth. However, the Remedial Investigation did not include methods that can enhance the ability to visually identify the occurrence of DNAPL contamination (e.g., screening soil with ultra-violet, fluorescence or hydrophobic dye, etc.). The occurrence of DNAPL would have a significant impact on the ability to restore portions of the aquifer where DNAPL is present.

VI. SUMMARY OF SITE RISKS

EPA prepared a Human Health Baseline Risk Assessment ("BLRA") and Ecological Risk Assessment ("ERA") for the Site in order to identify and define possible existing and future health risks and potential environmental impacts associated with exposure to the chemicals present in the various media at the Site if no action were taken. The BLRA and ERA provide the basis for taking action and indicate the exposure pathways that need to be addressed by the Remedial Action. The BLRA and ERA considered environmental samples collected prior to June 1995. Recent soil sampling and soil treatment activities completed in the carbon disulfide treatment zone provide additional data. Soil data collected after June 1995 have been considered in its entirety; however, the additional data were not incorporated into the quantitative risk assessment completed as part of the BLRA. The fundamental conclusion of the BLRA, that action is necessary to prevent contact with contaminated soil, sediment, surface water and ground water at the Site, remains unchanged. The BLRA and all environmental data can be found in the Administrative Record. The BLRA is composed of four parts, including Selection of Potential Chemicals of Concern (Hazard Evaluation); Exposure Assessment; Toxicity Assessment; and, Risk Characterization.

A. Human Health Baseline Risk Assessment

1. Selection of Chemicals of Potential Concern

Numerous chemicals, including VOCs, SVOCs (primarily polyaromatic hydrocarbons) and metals were detected in the environmental media (soil, sediment, surface water and ground water) sampled during the Remedial Investigation. All chemicals that were detected on the Site were screened against conservative risk-based screening concentrations. Chemicals whose concentrations exceeded screening values were characterized as chemicals of potential concern and were carried through the risk assessment process. Those chemicals that were found to pose a risk to human health are considered to be chemicals of concern. The complete rationale for selection of contaminants of concern can be found in the January 1997 Baseline Risk Assessment located in the Administrative Record for the Site.

Soil

The following chemical constituents were determined to be contaminants of concern ("COCs") for the soil medium:

On-Site Surface Soil (Industrial)	On-Site Subsurface Soil
Arsenic	Antimony
Carbon Disulfide	Arsenic
	Carbon Disulfide

Soil on Residential Parcel

Arsenic

Surface Water

None of the detected chemical constituents in surface water, either in the on-Site lagoon or tidal marsh were determined to be COCs with respect to human health risk. See Section VI.B.2 for a list of chemicals of concern identified within the surface water with respect to protection of aquatic life.

Sediment

Arsenic was the only COC in sediments located in both the on-Site lagoon and tidal marsh with respect to human health risk. See Section VI.B.2 for a list of chemicals of concern identified within the sediment with respect to protection of aquatic life.

Ground Water

The following chemical constituents were determined to be COCs for the ground water medium in the event that drinking water wells were installed either on-Site or in the immediate vicinity of the Site:

Columbia Aquifer

On-Site Ground Water	Downgradient Ground Water
ammonia arsenic carbon disulfide manganese thallium thiocyanate vinyl chloride zinc	ammonia antimony arsenic beryllium cadmium cobalt 1,1-dichloroethane 1,1-dichloroethene manganese nickel thallium thiocyanate toluene vinyl chloride zinc

Upper Potomac Aquifer

On-Site Ground Water	Downgradient Ground Water
arsenic beryllium cadmium cobalt manganese nickel thallium thiocyanate zinc	arsenic ammonia beryllium cobalt manganese nickel thallium thiocyanate vanadium zinc

2. Exposure Assessment

The following groups of individuals could be exposed to Site contaminants either currently and/or in the future and were evaluated in the BLRA:

- current and/or future commercial or industrial workers;
- current residents living on the parcel next to the Site and using the public water supply;
- future construction workers on the Site;
- future off-Site residents using ground water beneath or downgradient of the Site as a source of drinking or bathing water; and
- current and/or future trespassers.

Individuals could potentially be exposed to Site contaminants in various ways. There are three general routes through which individuals may be exposed to Site related contaminants: incidental ingestion, inhalation and dermal contact. The exposure routes evaluated in the BLRA include:

- placing objects such as hands contaminated with Site soil and sediment in the mouth;
- breathing vapors or contaminated dust from the Site;
- absorbing contaminants through the skin after touching contaminated soil or sediment;
- drinking, breathing toxicants while showering, and direct skin contact with ground water and surface water;
- eating fish from the on-Site lagoon.

Table 1
POTENTIAL RECEPTORS AND EXPOSURE FACTORS
FOR HUMAN HEALTH EVALUATION
(REASONABLE MAXIMUM EXPOSURE)
Halby Chemical Site

	Current Scenario		Future Scenario		
	Site Worker	Trespasser (age 9-12)	Child Resident	Adult Resident	Construction Worker
General Receptor Factors					
Body weight (kg)	70.0[c]	34.0[b]	15.0[c]	70.0[c]	70.0[c]
Inhalation rate (m^3/hour)	2.5[c]	0.7[g]	0.62[e]	0.83[c]	2.5[c]
Inhalation rate (m^3/day)	20.0[c]	17.0[g]	15.0[e]	20.0[c]	20.0[c]
Media-Specific Factors					
Soil (Surface/Subsurface):					
Inhalation rate (m^3/hour)	2.5[c]	0.7[g]	0.62[e]	0.83[c]	2.5[c]
Ingestion rate (mg/day)	50.0[c]	100.0[c]	200.0[c]	100.0[c]	480.0[c]
Exposure frequency (days/year)	250.0[c]	52.0[e]	350.0[c]	350.0[c]	250.0[c]
Exposure duration (years)	25.0[c]	4.0[g]	6.0[c]	24.0[c]	1.0[g]
Time spent outdoors (hour/day)	8.0[c]	1.8[b]	1.8[b]	1.8[b]	8.0[b]
Skin surface area (cm^2)	3,200[d,h]	4,600[d,h]	4,520[h,h]	5,300[d,h]	3,200[d,h]
Soil to skin adherence factor (mg/cm)	1.0[d]	1.0[d]	1.0[d]	1.0[d]	1.0[d]
Surface Water:					
Onsite lagoon, offsite marsh, incidental ingestion (liter/hr)	0.05[a]	0.05[a]		0.05[a]	
Skin surface in contact (cm^2)	5,800[d,h]	11,600[d,h]		20,000[d,h]	
Exposure time (hours/day)	1.0[d]	1.0[g]		1.0[d]	
Exposure frequency (days/year)	175.0[f]	52.0[e]		26.0[g,i]	
Exposure duration (year)	25.0[c]	4.0[g]		24.0[c]	
Sediment:					
Incidental ingestion (mg/day)	50.0[c]	100.0[d]		100.0[c]	
Skin surface in contact (cm^2)	5,800[d]	3,700[d]		5,800[d]	
Adherence Factor (mg/cm^2)	1.45[a]	1.45[a]		1.45[a]	
Exposure time (hours/day)	1.0[d]	1.0[g]		1.0[d]	
Exposure frequency (days/year)	175.0[f]	52.0[e]		26.0[g,i]	
Exposure duration (year)	25.0[c]	4.0[g]		24.0[c]	

Table 1
POTENTIAL RECEPTORS AND EXPOSURE FACTORS
FOR HUMAN HEALTH EVALUATION
(REASONABLE MAXIMUM EXPOSURE)
Halby Chemical Site

	Current Scenario		Future Scenario		
	Site Worker	Trespasser (age 9-12)	Child Resident	Adult Resident	Construction Worker
Groundwater (shallow, intermediate, deep):					
Ingestion (liter/day)			1.0[b]	2.0[a]	
Skin surface in contact while bathing/showering (cm^2)			7,000[a,h]	20,000[a,h]	
Time bathing/showering (hours)			0.33[a]	0.2[b]	
Exposure frequency (days/year)			350.0[c]	350.0[c]	
Exposure duration (years)			6.0[c]	24.0[c]	
Inhalation rate (m^3/hour)			0.62[c]	0.83[c]	
Fish:					
Locally caught fish ingestion (g/day)				6.5[e]	
Exposure frequency (days/year)				350.0[b]	

[a]USEPA. *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Part A, Interim Final*, USEPA/540/1-89/002, December 1989.

[b]USEPA. *Exposure Factors Handbook*. USEPA/600/8-89-043, June 1995.

[c]USEPA. *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors*, OSWER Directive 9285.6-03, March 25, 1991. (Soil exposure factors used for sediment.)

[d]USEPA. *Dermal Exposure Assessment: Principles and Applications*, January 1992.

[e]USEPA. Region III guidance (Nancy Rios).

[f]Public Health Evaluation, Halby Chemical Company Site, Wilmington, Delaware. EBASCO, 1990.

[g]Site observations, professional judgment, plausible upper boundary.

[h]Skin surface areas in contact with surface water or groundwater (while showering or bathing) are based on ranges. The total adult male surface area ranges from 17,000 to 23,000 cm^2, with a mean of 20,000 cm^2; the mean is used in the table rather than the maximum. For the child resident, the total body surface area is 7,000 cm^2, the 50th percentile value of a 3- to 5-year-old child.

Skin surface areas in contact with soil are based on body part exposed: for the adult worker, head, hands, and forearms; for the adult resident, head, hands, forearms, and lower legs; for the child resident, head, hands, arms, feet, and lower legs. The youth trespasser calculation was based on the total skin surface for the 95 percentile child aged 9-12 years (1.85 m^2) times the default value of 0.25.

[i]Exposure frequency of future resident to surface water and sediment assumes one event per week from spring to fall.

[j]American Industrial Council. *Exposure Factors Sourcebook*, May 1994.

The objective of the exposure assessment is to estimate the amount of each chemical of concern at a site that may actually be taken into the body (i.e., the intake level or dose). Conservative modeling assumptions are used to estimate the amount of exposure (See Table 1). For example, in the hypothetical future use scenario which considers a resident installing a drinking water well on the property, adult residents are assumed to ingest 2 liters of water per day, 350 days per year, over a 30-year exposure duration[1]. Child residents are assumed to ingest 1 liter of water per day, 350 days per year for six (6) years. Body weights are specified as 70 kg for adults and 15 kg for children.

Inhalation exposures during showering are estimated using modeling techniques. The modeling technique for adults accounts for inhalation of contaminants during showering, as well as after showering while the person remains in the room. Dermal exposure for children while bathing is estimated assuming total body contact for 0.33 hours per day, 350 days per year for six years.

Carcinogenic risks are calculated as an incremental lifetime risk and, therefore, incorporate terms to represent the exposure duration (years) over the course of a lifetime (70 years, or 25,550 days). Noncarcinogenic risks are calculated using the concept of chronic and subchronic exposures.

There are currently no plans to install drinking water wells within the vicinity of the Site, but until recently there were no prohibitions in place. Therefore, a hypothetical future use scenario considering human consumption of ground water was included in the Baseline Risk Assessment. DNREC has recently established a ground water management zone in the vicinity, including the Halby Chemical Site, prohibiting the installation of public or domestic water supply wells.

3. Toxicity Assessment

The toxicity assessment characterizes the inherent toxicity of a compound and helps to identify the potential health hazard associated with exposure to each of the chemicals of concern. Toxicological values derived by EPA were used in the Risk Assessment. These values include reference doses ("RfDs") for adverse but non-carcinogenic effects and cancer slope factors ("CSFs") for the effects of known or possible human carcinogens.

RfDs, which are expressed in units of mg/kg-day, are estimates of lifetime daily exposure levels of chemicals for humans, including sensitive individuals, that are not likely to cause deleterious effects. Estimated intakes of chemicals from environmental media (e.g., the amount of a chemical ingested from contaminated drinking water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors are incorporated which help to ensure that the RfDs will not underestimate the potential for adverse noncarcinogenic effects.

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[1] 30-year exposure duration assumes that exposure occurs 6 years as a child and 24 years as an adult.

Alternative D-3: Slurry Wall Around DNAPL, Inject Surfactant, Extract and Treat Surfactant and DNAPL, Institutional Controls

Capital Cost:	$1,200,000
Annual O&M Cost:	$4,700,000
Total Present Worth Cost:	$54,200,000
Time to Implement:	10 months

This alternative is based upon Alternative GC-6 in the FS with modifications by EPA and could supplement the ground water alternatives described above.

Carbon disulfide DNAPL has been observed in excavations as deep as 12 feet below the ground surface, above a local gray clay layer. In January 1998 an *in situ* chemical oxidation process was completed in the carbon disulfide treatment zone. The treatment process successfully reduced the concentration of carbon disulfide located in the uppermost 12 feet of soil to an average of less than 250 ppm (the treatment objective was an average of less than 1,010 ppm). The objective of Alternative D-3 would be to remove carbon disulfide located between 12 and 30 feet below the surface. A thick clay layer separating the Columbia and Upper Potomac water-bearing formations is located at the approximate 30-feet depth.

This alternative includes installing a slurry wall approximately 1,500 feet long around the carbon disulfide treatment zone. The slurry wall would be constructed through the Columbia formation as describe in Alternative G-3. It is assumed that additional DNAPL is directly beneath the carbon disulfide treatment zone (see Figure 3). Further investigation of the location and volume of carbon disulfide DNAPL would be completed prior to establishing final slurry wall alignment.

After the slurry wall is constructed, a surfactant would be injected into the interior of the wall through a series of four injection wells. Conceptually, the surfactant would be injected at a rate of one gallon per minute at each well. The DNAPL/surfactant/ground water mixture would be extracted through one extraction well at the lowest elevation within the base of the walled area and transported to an off-Site thermal oxidation treatment facility.

A treatability study and pilot study would be necessary to determine the most effective surfactant. Significant issues to be resolved would include: 1) finding an effective surfactant which is not itself unacceptably hazardous to the environment; 2) designing a slurry wall composition compatible with the hazardous constituents involved in the project; and 3) establishing safeguards to avert significant mobilization of the carbon disulfide in the aquifer.

The projected duration of remediation is 17 years of continuous pumping and treating of extracted ground water surfactant fluid.

Similar to Alternative D-2, institutional controls would be put in place in conformance with the GMZ established by DNREC encompassing the Halby Chemical Site. EPA would establish deed restrictions to further prevent the installation of wells on the parcels comprising the Site.

Monitoring of ground water in the Columbia, Upper Potomac and Lower Potomac Aquifers would be conducted to track Site-related contamination over time.

Alternative D-4: Extract and Treat DNAPL from Columbia Aquifer, Institutional Controls

Capital Cost:	$510,000
Annual O&M Cost:	$660,000
Total Present Worth Cost:	$10,700,000
Time to Implement:	5 months

This alternative is based upon Alternative GC-7 in the FS with modifications by EPA and could supplement the ground water alternatives described above.

This alternative is similar to Alternative D-3 in that it targets extraction and treatment of carbon disulfide DNAPL but no slurry wall would be installed nor would a surfactant be introduced into the aquifer. One or more extraction wells would be placed at the lowest elevation(s) and recessed into the Upper Potomac clay within the carbon disulfide contaminated area. Further investigation of the location and volume of carbon disulfide DNAPL would be completed prior to establishing specific extraction well location(s). Because of the viscosity of carbon sulfide, it is anticipated that intermittent pumping would be required to allow the DNAPL to recharge the area of influence of the extraction well(s). The recovered carbon disulfide would be hauled to an off-Site thermal oxidation treatment facility. Although this technique has been used at other sites to extract some DNAPL mass from the environment, it has never successfully removed all of the DNAPL. The cost estimate for this alternative is based on a 30-year project period, however, operation is expected to continue beyond 30 years.

Similar to Alternative D-2, institutional controls would be put in place in conformance with the GMZ established by DNREC encompassing the Halby Chemical Site. EPA would establish deed restrictions to further prevent the installation of wells on the parcels comprising the Site. Monitoring of ground water in the Columbia, Upper Potomac and Lower Potomac Aquifers would be conducted to track Site-related contamination over time.

VIII. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

Each of the remedial alternatives described above was evaluated using nine criteria. The resulting strengths and weaknesses of the alternatives were then weighed to identify the alternative providing the best balance among the nine criteria. These nine criteria are:

Threshold Criteria

- Overall protection of human health and the environment: Whether the remedy provides adequate protection and how risks posed through each pathway are eliminated, reduced or controlled through treatment, engineering controls, or institutional controls.

- Compliance with ARARs: Whether or not a remedy will meet all applicable or relevant and appropriate requirements ("ARARs") of Federal and State environmental statutes and/or whether there are grounds for invoking a waiver. Whether or not the remedy complies with advisories, criteria and/or guidance that may be relevant.

Primary Balancing Criteria

- Long-term effectiveness and permanence: The ability of the remedy to maintain reliable protection of human health and the environment over time once the cleanup goals are achieved.

- Reduction of toxicity, mobility or volume through treatment: The extent to which the alternative will employ treatment to reduce the toxicity, mobility, or volume of the contaminants causing the site risks.

- Short-term effectiveness: The time until protection is achieved and the short-term risk or impact to the community, on-Site workers and the environment that may be posed during the construction and implementation of the alternative.

- Implementability: The technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement that remedy.

- Cost: Includes estimated capital, operation and maintenance, and net present worth costs. The present worth analysis is used to evaluate expenditures that occur over different time periods by discounting all future costs to a common base year, usually the current year. This analysis allows the cost of remedial action alternatives to be compared on the basis of a single figure representing the amount of money that, if invested in the basis year and disbursed as needed, would be sufficient to cover all costs associated with the remedial action over its planned life.

Modifying Criteria

- State Acceptance: Whether the State of Delaware concurs with, opposes, or has no comment on the Selected Remedy.

- Community Acceptance: Whether the public agrees with the proposed remedy. This is assessed in detail in the ROD responsiveness summary (attached) which addresses public comments received on the Administrative Record and the Proposed Plan.

A. Overall Protection of Human Health and the Environment

A primary requirement of CERCLA is that the selected remedial alternative be protective of human health and the environment. A remedy is protective if it reduces current and potential risks to acceptable levels under the established risk range posed by each exposure pathway at the Site.

Soil Alternative 1 (No Action), would not effectively reduce risk to human health and the environment. The Site workers and adjacent residents would continue to be exposed to potentially harmful levels of contaminants in soil. Contaminated surface soil would continue to erode off-Site and into area surface water. Both current and potential future users of the Site would be exposed to unacceptable human health risks as indicated previously in Table 2. In addition, adverse ecological impacts would continue unabated at the Site. Because this alternative does not meet the threshold criteria of protection of human health and the environment, it will not be considered further in this analysis.

Alternatives S-2, S-3, S-4 and S-5 are all protective of human health and the environment. Each of these alternatives reduces the potential for exposure to and migration of Site contaminants, but each does it in a different way. Under Alternative S-2, the contaminated soil would remain in place, but the threat posed to people or animals from contact with the contaminated soil and the potential for further migration is reduced by placing a cap over the contaminated soil. Alternative S-3 stabilizes the soil to immobilize the contaminants prior to construction of the cap. Alternative S-4 separates and removes the concentrated waste for off-Site disposal and backfills the excavated areas with clean soil. Alternative S-5 excavates all contaminated soil and hauls it to off-Site landfills. Alternatives S-2 and S-3 include long-term monitoring to ensure the engineering controls continue to be effective and institutional controls to restrict the use of the Site and prevent potential exposure to any remaining contaminants.

Lagoon and Marsh Alternative LM-1 (No Action), would not effectively reduce risk to human health and the environment. Both Site workers and trespassers would have the potential for unacceptable risks as indicated previously in Table 2. In addition, adverse ecological impacts would continue unabated at the Site. Because this alternative does not meet the threshold criteria of protection of human health and the environment, it will not be considered further in this analysis.

Alternatives LM-2, LM-2A, LM-3, LM-4 and LM-4A are all protective of human health and the environment. Each of these alternatives reduces the potential for exposure to contaminated lagoon and marsh sediment. Alternatives LM-2 and LM-2A would involve excavating sediment, installing a geomembrane liner and re-establishing a wetland system on this industrial parcel. Alternatives LM-3 and LM-4 would fill the on-Site lagoon and marsh with clean soil and require the compensatory creation or restoration of a wetland system at an off-Site location which would have a better chance of long-term health. Alternatives LM-2 and LM-2A include extensive long-term monitoring to detect any re-degradation of the created wetlands.

Alternative LM-4A would be protective of human health, as potential for exposure to sediment with the highest concentrations of contaminants would be reduced through installation of a cap. The degree to which alternative LM-4A would be protective of the environment is marginal as the southern portion of the marsh would be managed by long-term monitoring by chemical and biological methods. Although the southern marsh is not as severely degraded as the north/central portion of the marsh, several inorganic compounds are present in sediment at concentrations many times greater than levels known to be safe. Alternative LM-4A relies on natural attenuation of contaminant concentrations within sediment to achieve safe levels for the wildlife in the southern portion of the marsh. Natural attenuation is natural treatment and reduction of contaminant concentrations through collective natural processes such as dilution, dispersion, desorption, and volitilization of contaminants.

Ground Water and DNAPL Alternatives G-1 and D-1 (No Action), would not effectively reduce risk to human health and the environment. People would have the potential for unacceptable risks posed by consuming ground water as indicated previously in Table 2 of Section VI (Summary of Site Risks). No persons are currently drinking contaminated water withdrawn from the Columbia or Upper Potomac Aquifers; however, if no action were taken it is plausible that drinking water wells may be installed in the future. Because these alternatives do not meet the threshold criteria of protection of human health and the environment, they will not be considered further in this analysis. In addition, Alternatives G-1 and D-1 would not require the continued monitoring of ground water which may be important in detecting any potential future migration of contaminants to the underlying Lower Potomac Aquifer.

Alternatives G-2, G-3, G-4 and G-5 are all protective of human health and the environment if employed in combination with a lagoon/marsh alternative which prevents ground water from discharging to the surface; Alternatives D-2, D-3, and D-4 would be implemented as enhancements to Alternatives G-2 through G-5 to target carbon disulfide DNAPL in ground water. The common element, and most important component, to each of these ground water protection alternatives is institutional controls to prevent the installation of drinking water wells in the vicinity of the Site. Alternatives G-3, G-4 and G-5 (along with the DNAPL enhancement provisions) each include active treatment of ground water or construction of engineering controls to reduce the migration of contaminated ground water. A mathematical model predicts that Alternative G-5 has the potential to restore the ground water to drinking water quality in approximately 50 years if the source of contaminants (all contaminated soil and subsurface DNAPL) is completely removed. However, the presence of the carbon disulfide DNAPL would make restoration unlikely. Alternative G-4 includes extraction and treatment of ground water to contain the contamination on the Halby Chemical property. Although restoration could eventually occur under this alternative, the time frame is likely to be several hundred years. Alternative G-3 includes the installation of a slurry wall through the Columbia Aquifer and along the perimeter of the Site. The objective of Alternative G-3, like Alternative G-4, is to reduce the migration of contaminated ground water beneath the Halby Chemical property to the downgradient Potts Property State Superfund Site. In summary, Alternatives G-2 through G-5 and D-2 through D-4 do achieve protection of human health through implementation of institutional controls. Alternatives G-2 through G-5 include long-term monitoring.

B. Compliance with ARARs

Any cleanup alternative selected by EPA must comply with all applicable or relevant and appropriate federal and state environmental requirements. *Applicable* requirements are those substantive environmental standards, requirements, criteria, or limitations promulgated under federal or state law that are legally applicable to the Remedial Action to be implemented at the Site. *Relevant and appropriate* requirements, while not being directly applicable, address problems or situations sufficiently similar to those encountered at the Site that their use is well-suited to the particular site. The remedial alternatives evaluated in this Record of Decision could be implemented so as to comply with their respective ARARs.

Chemical-Specific ARARs

Soil/Sediment: There are currently no ARARs establishing acceptable concentrations for contaminants in soil or sediment at the Site. However, as noted previously, the BLRA and Ecological Risk Assessment determined that the concentration of contaminants in the soil and sediment at this Site do present an unacceptable risk to human health and the environment. The Site-specific cleanup goal for soil in the industrial portion of the Site is 38 ppm arsenic. The cleanup goal for the residential parcel is 14 ppm arsenic.

Surface Water: Water quality standards have been established for acceptable concentrations of contaminants in State waters and are set forth in Delaware Surface Water Quality Standards ("DSWQS"), as amended February 26, 1993. DSWQS would be applicable to ground water pump and treat alternatives (G-3 through G-5, D-3 and D-4). The discharge from the water treatment plant will comply with DSWQS. In addition, a long-term monitoring program for restoration of wetlands on-Site (Alternatives LM-2, LM-2A and LM-4A) would include monitoring of surface water at the Site to measure any adverse impact due to migration of contaminants from the Site.

Action-Specific ARARs

Water Wells: The construction, operation and maintenance of any ground water extraction or monitoring well would be completed in conformance with Delaware Regulations Governing Construction and Use of Wells, as amended (April 6, 1997).

Discharge of Treated Ground water: The ground water extraction and treatment component of Alternatives G-3 and G-4 involve discharging treated water from the ground water treatment system into surface water. The more stringent of the substantive requirements of the Clean Water Act and the Delaware Regulations Governing Control of Water Pollution, as amended (June 23, 1983), regarding discharges to surfaces waters would be applicable to such discharges, including 40 C.F.R. Part 122 (National Pollutant Discharge Elimination System), 40 C.F.R. Part 131 (Water Quality Standards), Delaware Surface Water Quality Standards, as amended

(February 26, 1993) regarding water quality criteria which must be used in the development of the discharge limits.

Underground Injection of Treated Water: Alternative G-5 which includes the underground injection of treated water would comply with the Safe Drinking Water Act Underground Injection Control Program ("UIC") set forth at 40 C.F.R. Parts 144-147.

Identification of Hazardous Wastes: Excavated soils, sediments, extracted DNAPL or DNAPL/Surfactant mix, or water treatment plant residuals would be evaluated in accordance with the federal and state hazardous waste identification requirements (40 C.F.R. § 261.20-.24; DRGHW § 261.20-.24). On-Site handling of any materials determined to exhibit a characteristic of a hazardous waste would comply with the substantive portions of federal and state regulations that pertain to generators of hazardous waste (40 C.F.R. § 262.10, .20, .21, .23, .42, .50-.55, .57; DRGHW § 262.10-.33, .40, .42, .50) and transporters of hazardous waste (DRGHW § 263.30-31). (Applicable to alternatives involving excavation of contaminated soils or sediments and residual sludge or filter cake from on-Site water treatment plant)

Hazardous Waste Stored or Stockpiled: Several of the alternatives would include a considerable amount of excavation, extraction and handling of hazardous materials on-Site. The hazardous materials would have to be temporarily stored or stockpiled until their ultimate disposition is completed (i.e., stabilized, soil washed, consolidated for off-Site transport, etc.). Any on-Site storage of characteristic hazardous waste would comply with the substantive portions of federal and state requirements regulating containers (40 C.F.R. § 264.175; DRGHW § 264.171-.178), tanks (40 C.F.R. § 264.191-.196, .198, .199; DRGHW § 264.191-.199), and waste piles (40 C.F.R. § 264.251-.256, .259; DRGHW § 264.250-.258(a)), depending on the type of waste present and the manner in which it is stockpiled.

Treatment, Storage and Disposal of Hazardous Waste: Alternatives which involve on-Site recovery and treatment systems which handle hazardous or characteristic hazardous waste would meet the most stringent of federal and state requirements regulating hazardous treatment, storage and disposal facilities (40 C.F.R. Part 264; DRGHW Part 264).

Air Emissions: Air emissions from an air stripper included at a water treatment plant would meet Delaware Regulations Governing the Control of Air Pollution, Regulations Number 2 and 6.

Sediment and Storm water: A storm water and sediment management plan consistent with substantive portions of the Delaware Sediment and Stormwater Regulations must be developed and approved by EPA before construction disturbing over 5,000 square feet of land can begin.

Ground Water Management Zone: The ground water management zone discussed in each of the ground water alternatives was established by DNREC in a manner consistent with the State of Delaware Groundwater Management Plan (November 1, 1987) and Subsections 2.2, 3.2, 3.6, 4.2 and 4.4 of Delaware's Comprehensive State Ground Water Protection Program ("CSGWPP").

CSFs have been developed by EPA's Carcinogenic Assessment Group for estimating increased lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. CSFs, which are expressed in units of $(mg/kg\text{-}day)^{-1}$, are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to provide an upper-bound estimate of the increased lifetime cancer risk. The term "upper-bound" reflects the conservative estimate of the risks calculated from the CSF. Use of this approach makes underestimation of the actual cancer risk highly unlikely. CSFs are derived from the results of human epidemiological studies or animal bioassays to which animal to human extrapolation and uncertainty factors have been applied.

4. Risk Characterization

The January 1997 Baseline Risk Assessment characterized the potential health risks associated with both current and hypothetical future exposures to affected environmental media at the Halby Chemical Site.

The potential for health effects resulting from exposure to noncarcinogenic compounds is estimated by comparing an estimated daily intake presented by the Site conditions to the RfD. The ratio of the estimated daily intake to the RfD value, defined as the Hazard Quotient, provides an indication of the potential for systemic toxicity to occur. To assess the overall potential for non-carcinogenic effects posed by multiple chemicals, a Hazard Index ("HI") is derived by adding the individual hazard quotients for each COC. This approach assumes additivity of critical effects of multiple chemicals. EPA considers any HI exceeding one (1.0) to be an unacceptable risk to human health.

Increased lifetime cancer risks are determined by multiplying the intake level with the cancer potency factor. These risks are probabilities that are generally expressed in scientific notation (e.g., $1x10^{-4}$ or 1E-4). An increased lifetime cancer risk of $1x10^{-4}$ indicates that as a plausible upper bound, an individual has a one in ten thousand chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime assuming the specific exposure conditions. For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an increased upper bound lifetime cancer risk to an individual of between 1.0×10^{-4} (or 1 in 10,000) and 1.0×10^{-6} (or 1 in 1,000,000).

A summary of total human health risks at the Site is presented in Table 2. For example, the potential carcinogenic risk posed to Site workers by on-Site soil and lagoon sediment as $1.3x10^{-3}$ and $2.0x10^{-3}$, respectively. The combined risk to workers from both soil and sediment is $3.3x10^{-3}$, meaning that approximately one additional person out of 300 exposed is at risk of developing cancer. The potential additional carcinogenic risk posed to Site workers by soil alone is $1.3x10^{-3}$, or one in 770 persons. The calculated carcinogenic risk presented by exposure of youth trespassers to on-Site soil and sediment is $1.4x10^{-4}$ and $1.7x10^{-4}$, respectively. The combined risk to youth trespassers from both soil and lagoon sediment is $3.1x10^{-4}$, or approximately one person out of 3,225 who continuously trespasses on the property is at an additional risk of developing cancer.

As described in Section VI.A.2 above, potential exposure routes were considered for various groups of individuals that could be exposed to Site contaminants. Table 2 summarizes the respective risk levels presented to each group of individuals by the various contaminated media.

Table 2
Human Health Risks at the Site[a]

Risk From On-Site Soil[b]	**Cancer Risk**	**Hazard Index[e]**
Site Worker exposed to soil	1.3×10^{-3}	9.9
Construction Worker exposed to soil	1.9×10^{-4}	34.2
Youth Trespasser exposed to soil	1.4×10^{-4}	5.8
Risk From Sediment[c]	**Cancer Risk**	**Hazard Index**
Site Worker exposed to: lagoon sediment tidal marsh sediment	2.0×10^{-3} 7.0×10^{-4}	13.2 4.3
Youth Trespasser exposed to: lagoon sediment tidal marsh sediment	1.7×10^{-4} 5.7×10^{-5}	7.1 2.2
Risk From Surface Water[b]	**Cancer Risk**	**Hazard Index**
Site Worker exposed to: lagoon surface water tidal marsh surface water	6.7×10^{-5} 1.2×10^{-6}	1.5 0.1
Youth Trespasser exposed to: lagoon surface water tidal marsh surface water	7.3×10^{-6} 1.4×10^{-7}	0.6 0.1
Risk From Ground Water (Hypothetical Exposure)[d]	**Cancer Risk**	**Hazard Index**
Off-Site Resident exposed to the Columbia Aquifer beneath the Site	1.3×10^{-2}	446.0 (child) 177.0 (adult)
Off-Site Resident exposed to the Columbia Aquifer downgradient of the Site	4.0×10^{-2}	1103.2 (child) 472.6 (adult)
Off-Site Resident exposed to the Upper-Potomac Aquifer beneath the Site	8.1×10^{-4}	1304.0 (child) 550.2 (adult)
Off-Site Resident exposed to the Upper-Potomac Aquifer downgradient of the Site	8.0×10^{-4}	531.1 (child) 230.0 (adult)
Risk From Soil on Residential Parcel[b]	**Cancer Risk**	**Hazard Index**

Resident exposed to soil on adjacent property	3.8×10^{-4}	8.2 (child) 1.3 (adult)

[a] Risks were calculated using the lowest value of either the 95% upper confidence limits of the average or the maximum concentration detected for the exposure concentration
[b] Combined risk and hazard index due to dermal contact, inhalation and inadvertent ingestion exposure routes
[c] Combined risk and hazard index due to dermal contact and ingestion
[d] Combined risk and hazard index due to ingestion, inhalation, and dermal absorption while showering or bathing
[e] The Hazard Index as shown is the sum of all hazard quotients, regardless of the critical effect or target organ

Arsenic is responsible for almost all of the elevated carcinogenic risk and noncarcinogenic hazard posed to people by contaminated soils both on the Site and on the adjacent residential parcel. Arsenic is a natural constituent of all soils and is commonly found at levels exceeding 10^{-6} risk. The local mean arsenic background concentration has been found to be approximately 14 ppm.

EPA and DNREC have determined that preventing exposure to on-Site contaminated soil exceeding 38 ppm of arsenic at the Halby Chemical Site would reduce the excess lifetime cancer risk to less than 1.0×10^{-5} and a Hazard Index of less than 1.0 (arsenic concentration of 64 ppm in on-Site soils leads to a HI of 1.0). This remediation target would reduce the probability of future Site workers developing cancer as a result of exposure to Site soil from one in 770 to less than one additional person in 100,000.

EPA and DNREC have determined that preventing exposure to soil with an arsenic concentration averaging greater than 14 ppm on the residential parcel would reduce the excess lifetime cancer risk to less than 3.3×10^{-5} and the Hazard Index to less than 1.0 (arsenic concentration of 23.5 ppm in residential soil leads to a HI of 1.0). This residential remediation target would reduce the probability of developing cancer as a result of exposure to contaminants in soil from one in 2,630 to less than one additional person in 33,000.

The current risk and hazard presented by contaminated ground water is zero, because no one is drinking the ground water. Delaware DNREC has implemented a ground water management zone in the vicinity of the Site which makes installation of a public or domestic water supply well in the vicinity of the Site unlawful.

All groups of individuals could be exposed to unacceptable health risks if Site contamination is not addressed and no restrictions are placed on future use of the Site. Actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response selected in this ROD, may present an imminent and substantial endangerment to human health or welfare.

B. Environmental Risk Evaluation

The principal purpose of the ecological risk assessment is to determine the likelihood that ecological receptors are exposed to unacceptable risks from Site contaminants. The ERA evaluated the ecological risks associated with the Site, primarily focusing on the aquatic ecosystem of the on-Site lagoon and adjacent tidal marsh. The overall evaluation is based on: (1) chemical analyses of sediment, surface water, and soil compared to appropriate benchmarks; (2) survey of the benthic macroinvertibrate community; and, (3) the results of toxicity bioassay studies. The ecological risk assessment consisted of three primary components; site characterization (ecosystem components summarized in Paragraph V.A.6), exposure analysis, and risk characterization.

1. Exposure Assessment

See Paragraph V.A.6 (Ecology) for description of Site ecological setting. For the purposes of ecological risk analysis the areas evaluated included the wetland environments including the on-Site lagoon with perimeter uplands, the I-495 drainage ditch and the tidal marsh east of the Site.

The ERA utilized a combination of preliminary screening methods to evaluate potential contaminants of concern. These methods include ecological surveys to evaluate environmental conditions and laboratory studies to expose test organisms to water and/or sediments collected from the waterways affected by the Site.

For initial exposure evaluation, the reasonable maximum exposure ("RME") concentrations for detected chemicals are used as the basis for calculating chemical exposure for aquatic species. It is assumed that these concentrations are uniformly distributed in the sampled media and are available to ecological receptors.

The preliminary soil and sediment screening was performed by examining chemical concentrations in relation to conservative criteria assembled by the EPA Region III Biological Technical Assistance Group. The criteria are assembled from scientific publications evaluating chemical toxicity to ecological receptors, such Long and Morgan's The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program, with respect to sediment. For chemicals found in sediment, the toxicity measurement endpoints are the effects range-low ("ER-L") and effects range-median ("ER-M") data from Long and Morgan (1991). An ER-L value defines the concentration at the low-end of the range in which effects were observed. An ER-M concentration defines a point midway in the range of reported values associated with biological effects. In the event that a soil or sediment concentration screening level was lower than concentrations representative of background conditions, the background concentration was considered the benchmark.

For chemicals found in surface water chronic toxicity benchmarks are the lower of ambient water quality criteria ("AWQC") for aquatic life established by EPA in "Quality Criteria for Water

Update #2 1987," (EPA, 1987) and 40 CFR Part 131, or Delaware Surface Water Quality Standards for aquatic life established by DNREC, as amended February 26, 1993.

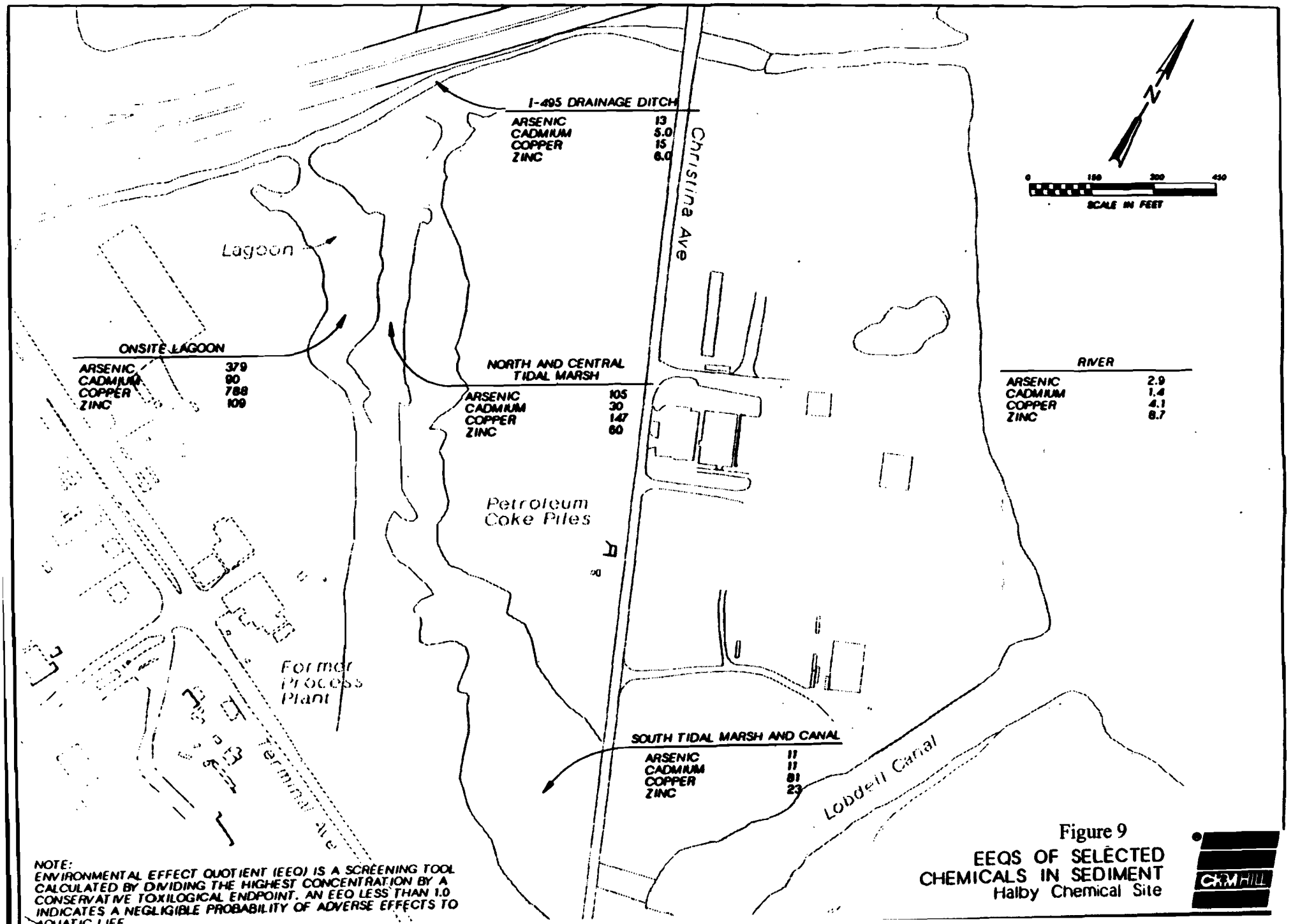
2. Risk Characterization

Potential risks to ecological receptors are initially characterized in the ERA by using the quotient method. In this method, the environmental concentration is divided by an appropriate toxicological endpoint. An environmental effect quotient ("EEQ") of less than one (1) or unity indicates a negligible probability of adverse effects. If the EEQ is equal to or greater than one, then there may be an ecological effect. As the magnitude of the quotient increases, the likelihood of possible effects is assumed to increase. This risk characterization is suitable for preliminary identification of possible organism-level effects. Effects to trophic levels and communities may be extrapolated from these results.

For some of the contaminants, a concentration gradient exists along the historical flow path of aqueous wastes discharged to the on-Site lagoon from the former Halby Chemical production facility (see Figure 9). The aqueous wastes would flow from the on-Site lagoon to the adjacent tidal marsh through a culvert beneath the railroad tracks and then south through the marsh to the Lobdell Canal. There is an apparent gradient in concentration of arsenic, cadmium, copper and zinc in sediment with distance from the lagoon through the tidal wetland. Concentrations of ammonia and thiocyanate, two chemicals known to be Site-related based on Halby Chemical plant records, are high in the Site lagoon sediment but higher in the northern and central portions of the tidal marsh. Neither ammonia nor thiocyanate were found at elevated levels in the southern tidal marsh sediment. The Lobdell canal is a constructed waterway connecting the southern portion of the tidal marsh to the Christina River.

A survey of benthic macroinvertibrates was completed to gauge environmental conditions. Macroinvertibrate inhabitants of lagoon, tidal marsh and ditch sediments were qualitatively evaluated during the aquatic habitat assessment. Only three benthic taxa were collected in the lagoon and were dominated by oligochaetes. The control site, approximately 7 miles up the river from the Site, had a total of 16 taxa and the greatest number of macroinvertibrates. The collection station in the southern tidal marsh yielded eight taxa, the station in the central marsh yielded 6 taxa and the station in the I-495 drainage ditch yielded 3 taxa. Using indices on pollution tolerance and biological impairment, the benthic macroinvertibrate study concluded that organisms present in the lagoon and marsh sediments were subject to environmental stress.

Laboratory analyses of samples collected have identified many chemicals, primarily inorganic compounds or metals, at levels much higher than concentrations known to be protective of aquatic plants and animals. Further, studies completed in the laboratory by exposing test animals to Site sediment or water extracted from Site sediment indicate that the lagoon and northern and central portion of the tidal marsh are causing harm to animals living there. The studies also suggest that contaminated sediments may be causing harm to animals living in the southern marsh.



NOTE:
ENVIRONMENTAL EFFECT QUOTIENT (EEQ) IS A SCREENING TOOL CALCULATED BY DIVIDING THE HIGHEST CONCENTRATION BY A CONSERVATIVE TOXILOGICAL ENDPOINT. AN EEQ LESS THAN 1.0 INDICATES A NEGLIGIBLE PROBABILITY OF ADVERSE EFFECTS TO AQUATIC LIFE.

Figure 9
EEQS OF SELECTED CHEMICALS IN SEDIMENT
Halby Chemical Site

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The most recent bioassay tests found that more than 70% of the test organisms died upon exposure to water extracted from sediment collected from the bottom of the lagoon. Subsequent tests run to determine the specific contaminant or contaminants causing the death of the animals were unable to discern a single contaminant responsible for the mortality. Any one, or several, of the dozens of different substances found at elevated concentrations within the lagoon sediment could cause or contribute to the observed mortality of test animals

The surface water in the on-Site lagoon contains concentrations of several chemical compounds and metals, including arsenic, chromium, copper, iron, lead, nickel, carbon disulfide, cyanide and ammonia which have the potential to have significant adverse impacts on the aquatic ecosystem. Surface water in the tidal marsh contains potentially harmful concentrations of cyanide, iron and zinc. Ground water, which may be a pathway by which chemicals are discharged to the lagoon, tidal marsh, or river, is contaminated by several contaminants of ecological concern, particularly arsenic, iron and zinc.

It must be noted that surface soil across the Site contains concentrations of metals such as arsenic, lead, copper and zinc at levels that have a high potential to affect ecological receptors. With respect to upland areas of the Site, the current and future industrial land use make it unlikely that wildlife would reside in any area other than the perimeter of the lagoon; however, transient exposure is likely. Upland areas surrounding the marsh located on the Potts Site is being evaluated by DNREC under the authority of the Delaware Hazardous Substance Cleanup Act.

VII. DESCRIPTION OF REMEDIAL ACTION ALTERNATIVES

The Feasibility Study ("FS") Report discusses the range of alternatives considered to minimize potential exposure to contaminants of concern identified during the RI for the Site and together with the Administrative Record provides supporting information leading to the alternative selected by EPA. Each of the alternatives evaluated are based on those presented in the Feasibility Study.

This Section VII discusses alternatives for each of the areas requiring cleanup separately. The Selected Remedy presented in Section IX is a combination of the best area-specific alternatives. Based on the potential impacts to human health and the environment, the following areas and media (i.e., soil, water, sediment) of the Site warrant action to minimize potential exposure to hazardous substances:

- On-Site surface/subsurface soil (including soil within former process plant area)
- Lagoon and tidal marsh sediment and surface water
- Ground water
- DNAPL

The following summary includes a "No Action" alternative required by the NCP and a few cleanup options for each of the above areas/media. The options presented are those that are protective of human health and the environment, achieve state and federal regulatory requirements, and best achieve the cleanup goals for the Site. These alternatives are based on those presented in the Feasibility Study.

A brief description of the Alternatives and the detailed analysis of each follows below.

Alternative 1: No Action

Capital Cost:	$0
Annual O&M Cost:	$0
Present Worth Cost:	$0
Time to Implement:	0

The NCP requires that EPA consider a "No Action" alternative for every Superfund site to establish a baseline or reference point against which each of the Remedial Action alternatives are compared. In the event that the other identified alternatives do not offer substantial benefits in the protection of human health and the environment, the No Action alternative may be considered a feasible approach. This alternative leaves the Site in its current state and all current and potential future risks would remain. The no action alternative is the first alternative for each area discussed below (i.e., soil, lagoon, marsh and ground water).

A. Alternatives for Soil

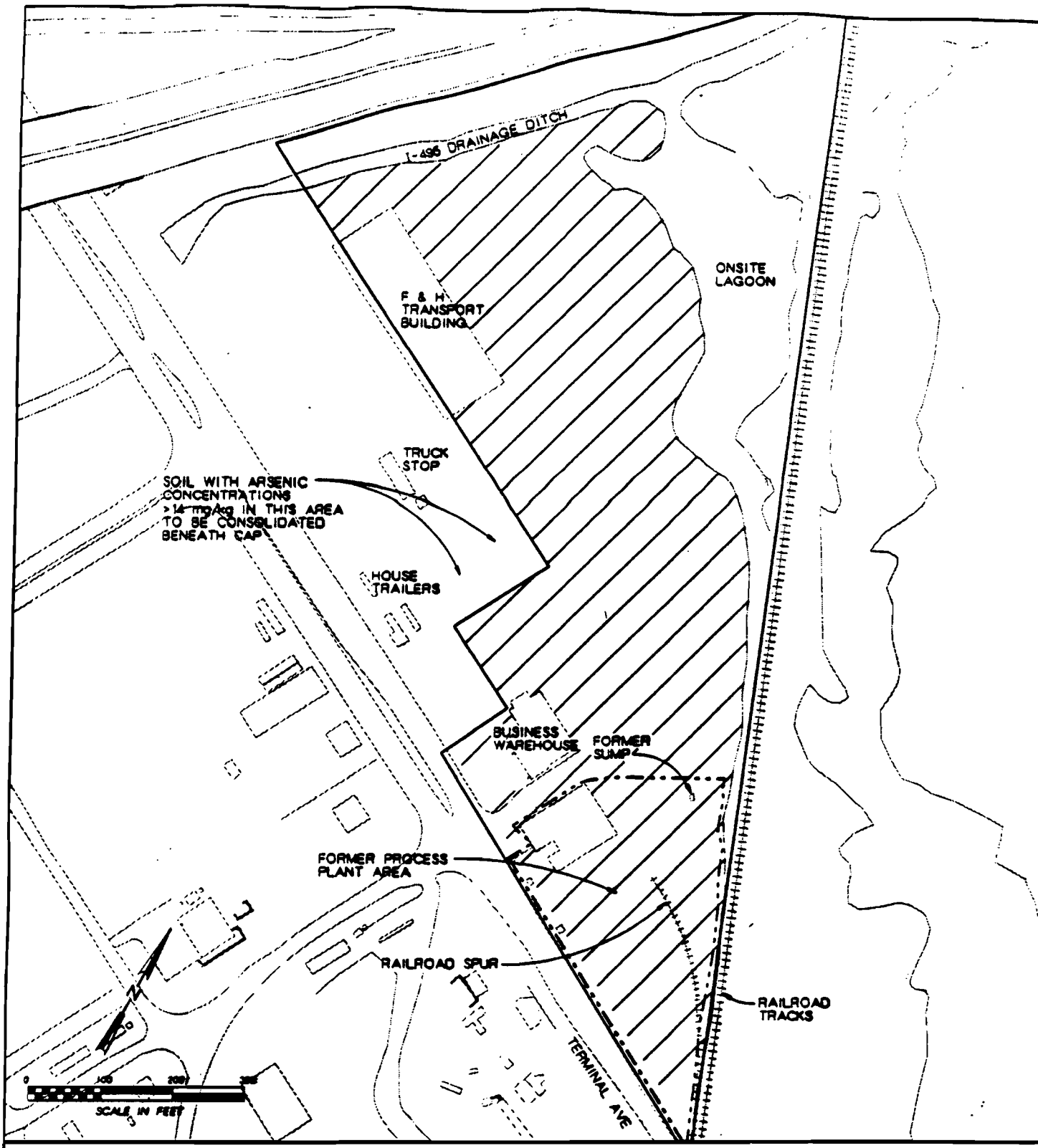
Alternative S-2: Cap with Paved Surface, Surface Water Runoff Controls, Long-Term Monitoring, and Institutional Controls

Capital Cost:	$1,550,000[2]
Annual O&M Cost:	$8,100
Total Present Worth Cost:	$1,700,000
Time to Implement:	10 months

This Alternative is based upon Alternatives S-2 and SS-2 from the FS, as modified by EPA, and includes the following components:

A cap with a paved surface designed to withstand loads consistent with industrial land use would be installed over the area of the Site where surface and/or subsurface soil exceed cleanup standards (Figure 10). The surface would consist of asphalt or a pavement constructed with an "environmentally friendly" binder. A conceptual drawing of the cap profile is included in

[2] All costs and implementation times referenced in this Record of Decision are estimates.



LEGEND

- HALBY CHEMICAL SITE
- FORMER PROCESS PLANT AREA BOUNDARY
- LIMITS OF CAPPING

Figure 10

LIMITS OF SOIL CAPPING
ALTERNATIVE S-2
(ARSENIC CONCENTRATION >38 mg/kg)
Halby Chemical Site

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Figure 11; the actual cap profile (materials and thickness of respective layers) will be developed in the design. The cap would reduce the risk of direct exposure to the soil contaminants and control migration of contaminated soil. This cap would also reduce the amount of precipitation which infiltrates through contaminated soil above the water table and into the ground water. The actual size and locations of the capped areas would be determined during the Remedial Design phase of the project. All Site soils containing greater than 38 ppm arsenic would be capped, including the carbon disulfide treatment zone.

Contaminated surface soil which has eroded onto the adjacent residential property would be excavated and consolidated under the cap along with existing contaminated soil. The performance standard for soil on the residential parcel is 14 ppm arsenic. Preliminary soil sampling indicates that excavation on the residential property may be limited to a depth of approximately three feet in the backyard. The residential property would be backfilled with clean fill material, six inches of topsoil and vegetated. In the event that the property were converted to industrial use prior to the clean-up of this parcel, the requirement to cap soils containing greater than 38 ppm arsenic would apply.

A passive type of gas collection system using gas vents may be necessary in areas above the vicinity of the carbon disulfide treatment zone. The appropriateness of a gas collection system will be determined during the design process.

An engineered surface water runoff and erosion control system would be designed in accordance with Delaware Storm Water Control Regulations and installed to control surface water runoff. The system would include surface grading and storm water retention basins and outfall structures, as necessary.

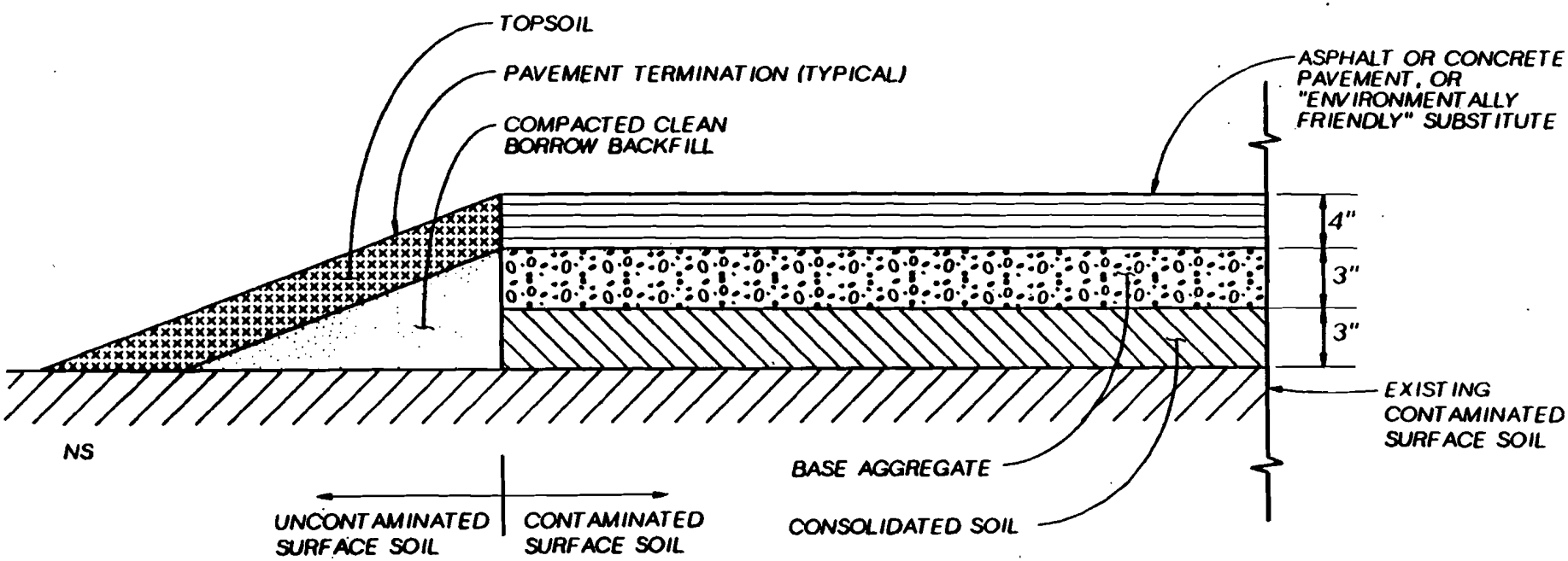
Operation and Maintenance would be performed to ensure the integrity of the cap. Maintenance activities would include periodic resealing and repairing cracks in the cap and gas monitoring, as appropriate.

The deed would be restricted to ensure the property is not used in a manner inconsistent with the remedy.

Alternative S-3: Stabilization of Contaminated Soil, Cap with Paved Surface, Surface Water Runoff Controls, Long-Term Monitoring, and Institutional Controls

Capital Costs:	$16,000,000
Annual O&M Costs:	$8,100
Total Present Worth Cost:	$16,100,000
Time to Implement:	13 months

This Alternative is based upon Alternatives S-3 and SS-3 from the FS, as modified by EPA, and includes the following components:



NOTE:
1. HYDRAULIC ASPHALT IN ACCORDANCE WITH ASPHALT INSTITUTE.

2. ACTUAL CAP PROFILE (MATERIALS AND THICKNESS OF RESPECTIVE LAYERS) WILL BE DEVELOPED IN THE REMEDIAL DESIGN.

Figure 11
TYPICAL WEAR SURFACE (CONCEPTUAL)
Halby Chemical Site

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This alternative is similar to Alternative S-2 described above with the exception that contaminated soil would be stabilized to reduce the potential for migration of contaminants to the ground water before being covered with a cap. Stabilization would be accomplished on-Site by large-scale mechanical mixing of contaminated soil with chemical reagents and/or cements of various types. Stabilization decreases the mobility and direct exposure potential of surface and subsurface soil.

Additional sampling to determine the actual volume of surface and subsurface soil exceeding 38 ppm arsenic cleanup standard and to better define the physical characteristics would be necessary during the design. The physical and chemical characteristics of soil are highly variable across the Site. Investigations have identified on-Site soil ranging from very fine particle sized silt (former lagoon sediment which have been filled over) to unsorted fill material including construction rubble. Specific areas containing high levels of hazardous substances have been isolated, making it difficult to predict the full extent of contaminated soil with certainty. Therefore, the volume of soil to be stabilized may be greater than currently known and the stabilization project may require the use of a variety of binding materials and/or mixes specific to each region on the Site. Additional analysis and treatability testing would be required during the Remedial Design to define the type and the volume of material to be stabilized and to develop the specific reagent mixes to be added to contaminated soil.

In some areas, such as the industrial yard between the lagoon and the Christiana Motor Freight office building, it may be cost effective to first excavate and stockpile the imported slag material, then stabilize the underlying contaminated soil and former lagoon sediment.

The remaining components of the remedy would be the same as those described above, in Alternative S-2.

Alternative S-4: Soil Washing, Stabilization of Separated Soil Fraction, Off-Site Disposal

Capital Cost:	$27,250,000
Annual O&M Costs:	$0
Total Present Worth Cost:	$27,300,000
Time to Implement:	16 months

This Alternative is based upon Alternatives S-4 and SS-4 from the FS, as modified by EPA, and includes the following components:

Contaminated soil would be excavated and segregated by density and grain size. Soil washing operates on the principle that most contamination is concentrated in the fine particle fraction and that contamination of larger particles generally is not extensive. Water and chemical reagents are added to produce a slurry feed that is fed through separators to remove contaminated silts and clays from larger granular particles.

Soil washing the former lagoon sediment located at depth would be of marginal utility as the intent of this soil washing technology is to separate fine particulates which hold a majority of the contaminants in the soil, thus reducing the volume of hazardous material to be managed. The former lagoon sediments are comprised of more than 70% fine grained particulates, therefore minimal volume reduction would be realized. Accordingly, the former lagoon sediment located at depth would be stabilized in place, similar to Alternative S-3.

The soil washing process produces three output streams: 1) a coarse clean fraction; 2) a contaminated consolidated fine fraction; and 3) a contaminated process wash water. The contaminated fine soil will likely require drying and disposal in an off-Site RCRA Subtitle C landfill. The process wash water will be treated on- or off-Site. Clean backfill would be added as needed to replace the contaminated fine fraction that was disposed of off-Site. A gravel surface layer would be applied over the backfill material to provide a working surface suitable for an industrial yard.

Alternative S-5: Soil Excavation and Off-Site Disposal, Clean Backfill

Capital Cost:	$8,100,000
Annual O&M Cost:	$0
Total Present Worth Cost:	$8,100,000
Time to Implement:	16 months

This alternative is based upon Alternative S-6 and SS-6 in the FS with modifications by EPA.

Contaminated surface and subsurface soil would be excavated, sampled and segregated. Soil determined to be RCRA-characteristic wastes based on the sampling program would be transported to a RCRA Subtitle-C hazardous waste landfill. Soil identified as RCRA-characteristic wastes due to metals contamination would be treated by a stabilization technology prior to land disposal. Soil which is RCRA-characteristic due to reactive sulfides would likely be treated by chemical oxidation prior to land disposal. Soil found to be contaminated with arsenic above the cleanup standards but determined not to be RCRA-characteristic wastes would be transported to a RCRA Subtitle-D landfill. The cost estimate for Alternative S-5 assumes that 90% of the volume will be sent to a RCRA Subtle-D landfill and 10% to a RCRA Subtitle-C landfill based on available data.

The excavated areas would be backfilled with clean material to replace the contaminated soil that was disposed of off-Site. A gravel surface layer would be applied over the backfill material to provide a working surface suitable for an industrial yard.

B. Alternatives for the Lagoon and Marsh[3]

Alternative LM-2: Sediment Excavation and Off-Site Disposal, Geomembrane Installation, Wetland Restoration, Long-Term Monitoring

Capital Cost:	$21,500,000
Annual O&M Cost:	$116,000
Total Present Worth Cost:	$23,800,000
Time to Implement:	23 months

This alternative is based upon Alternatives LS-4 and MS-5 in the FS with modifications by EPA.

The lagoon and marsh would be temporarily drained. The uppermost 18 inches of sediment would be excavated, an impermeable geomembrane would be installed over the excavated areas, and an 18-inch soil layer would be installed over the geomembrane to allow re-establishment of wetlands at current elevations. The imported soil would be fine particulate clay or silt with a high organic carbon fraction to support the reestablishment of a viable wetland. The geomembrane installed at the excavated areas would prevent underlying contaminated sediment and ground water from serving as a long-term contamination source to the restored wetland. Most carbon disulfide near the surface has been treated to less than 1,000 ppm; nevertheless, the composition of the geomembrane must be compatible with carbon disulfide. The restored wetland would be planted with wetland species.

The uppermost 12 inches of sediment in the I-495 drainage ditch located between Terminal Avenue and the Christina River would also be excavated and then backfilled to the original grade with clean material to establish a conduit for tidal-driven surface water to move into the lagoon. The lagoon inlet and the marsh inlet at the confluence with the Lobdell Canal would be designed with energy dissipaters to reduce potential for scouring of the lagoon and marsh bottoms.

For cost estimation purposes, it is assumed that a water treatment plant would be mobilized to the Site and operated to treat surface water extracted from the lagoon and marsh during construction activities. Standard sediment control measures will be evaluated for Site application during the Remedial Design. If engineering controls, such as a series of sedimentation basins, are determined sufficient to achieve adequate surface water quality during the lagoon and marsh construction activities the water treatment plant will not be required.

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[3] Each lagoon and marsh cleanup alternative assumes that: $1.5 million would be spent building a water treatment plant to treat surface water; and, six months would be required to build the water treatment plant before construction began on the lagoon. If appropriate standards can be met by implementing standard sediment and erosion controls, the projected cost and time estimates would be adjusted.

Excavated sediment from the lagoon, marsh, and I-495 drainage ditch would be dewatered and sent to an off-Site landfill. It is assumed that the material would require treatment prior to land disposal in a RCRA Subtitle-C landfill.

Long-term monitoring would be required to ensure the restored wetland retains its functional value and is not recontaminated by residual contamination. The monitoring program would include chemical monitoring of sediment and surface water in the lagoon, marsh, I-495 drainage ditch, the Lobdell Canal and the Christina River. The specific monitoring program would be developed during the Remedial Design. The monitoring plan would establish chemical-specific trigger values that would lead to the incorporation of biological testing methods.

Alternative LM-2A: Sediment Excavation with On- and Off-Site Disposal, Geomembrane Installation, Wetland Restoration, Long-Term Monitoring

Capital Cost:	$17,500,000
Annual O&M Cost:	$116,000
Total Present Worth Cost:	$19,300,000
Time to Implement:	23 months

This alternative is based upon Alternative LS-2 and MS-5 in the FS with modifications by EPA.

This alternative is identical to Alternative LM-2 above, except some of the excavated sediment would be placed beneath the cap included in Alternative S-2 or S-3. The Site does not have enough area to consolidate all of the stabilized sediment on-Site, therefore, the excess volume would be transported to an off-Site landfill. For cost estimating purposes, 35% of approximately 110,000 tons of lagoon, marsh and I-495 drainage ditch sediments to be excavated would be dewatered, stabilized and graded over the portion of the Site to be capped. A cap would be constructed over the stabilized sediments.

The current and continued use of the Site to support industrial businesses limits the volume of material which can remain on-Site without materially altering the utility of the property. Alternative LM-2A would reduce the cost of implementing Alternative LM-2 by several million dollars by reducing the volume of material to be sent off-Site.

The remaining components of the remedy would be the same as those described in Alternative LM-2.

Alternative LM-3: Sediment Stabilization, Cap Lagoon with Paved Surface, Wetlands Compensation, Institutional Controls

Capital Cost:	$43,900,000
Annual O&M Cost:	$30,000
Total Present Worth Cost:	$44,600,000
Time to Implement:	25 months

This alternative is based upon Alternatives LS-5 and MS-4 in the FS with modifications by EPA.

The lagoon and marsh would be drained and contaminated sediment would be stabilized or solidified to a depth of 12 inches below the water table. Sediment in the I-495 drainage ditch would be excavated to a depth of 12 inches and consolidated with the lagoon and marsh sediment for stabilization. Clean fill would then be used to backfill the lagoon and marsh to surrounding grade. The lagoon would be capped with a surface such as asphalt pavement suitable for use in an industrial area. The former marsh area would be covered with topsoil and vegetated.

The surface elevation and material of the former marsh area would be consistent with existing uplands at the Potts Property State Superfund site (except that it would be free of chemical hazards). This would enable a final cover for the Potts Site to be extended in this area, pending a final cleanup decision by DNREC at the Potts Site.

Storm water management structures would be installed as necessary to comply with Delaware storm water control regulations. Displaced surface water would be handled in the same manner as Alternative LM-2.

The I-495 drainage ditch would be backfilled with clean soil to its previous grade to continue to provide a conduit for road runoff water to the Christina River.

Treatability testing would be required during the Remedial Design to develop the specific stabilization reagent mix to be added to contaminated sediment. Stabilization would reduce the potential for migration of contaminants from the sediment to ground water.

The elimination of the lagoon and marsh as wetlands (approximately 7 acres) would require compensation by creating healthy wetland habitat of equal or better function and value at an alternate location. The Halby Chemical Site is located in an industrial area completely surrounded by environmentally degraded parcels. The setting of the Site is significant in that the potential for successfully establishing and maintaining a healthy wetland habitat on a long-term basis, either on-Site or in the immediate vicinity, is low. The only source of high quality water to the created or enhanced wetland would be rain water landing directly upon the wetlands. Water quality of the Christina River in the vicinity of the Port of Wilmington is generally poor. Therefore, creation or enhancement of wetlands to compensate for the loss due to implementation of this remedy would be accomplished off-Site, preferably in the Christina River watershed, at a specific location to be determined in consultation with federal, state and local authorities.

Operation and Maintenance would be performed to ensure the integrity of the cap in both the lagoon and marsh areas. On-Site maintenance activities would include periodically resealing and repairing cracks in the cap. Long-term monitoring would be required to confirm that the containment components are preventing off-Site migration of Site-related contaminants. The monitoring program would include chemical monitoring of sediment and surface water in the I-495 drainage ditch, the Lobdell Canal and the Christina River. The specific monitoring program

would be developed during the Remedial Design. The monitoring plan would establish chemical-specific trigger values that would lead to the incorporation of biological testing methods. Off-Site activities would include appropriate monitoring and/or maintenance of the created/enhanced wetland.

The deeds would be restricted to ensure the lagoon and marsh property is not used in a manner inconsistent with the remedy.

Alternative LM-4: Backfill, Cap Lagoon with Paved Surface, Wetlands Compensation, Institutional Controls

Capital Cost:	$6,640,000
Annual O&M Cost:	$30,000
Total Present Worth Cost:	$7,300,000
Time to Implement:	10 months

This alternative is based upon Alternatives LS-6 and MS-3 in the FS with modifications by EPA.

Sediment in the I-495 drainage ditch would be excavated to a depth of 12 inches and consolidated with the lagoon and marsh sediment. Clean fill would then be used to backfill the lagoon and marsh to surrounding grade. The lagoon would be capped with a surface such as asphalt pavement suitable for use in an industrial area. The former marsh area would be covered with topsoil and vegetated.

The surface elevation and material of the former marsh area would be consistent with existing uplands at the Potts Property State Superfund site (except that it would be free of chemical hazards). This would enable a final cover for the Potts Site to be extended in this area, pending a final cleanup decision by DNREC at the Potts Site.

Storm water management structures would be installed as necessary to comply with Delaware storm water control regulations. Displaced surface water would be handled in the same manner as Alternative LM-2.

The I-495 drainage ditch would be backfilled with clean soil to its previous grade to continue to provide a conduit for road runoff water to the Christina River.

The elimination of the lagoon and marsh as wetlands (approximately 7 acres) would require compensation by creating healthy wetland habitat of equal or better function and value at an alternate location. The Halby Chemical Site is located in an industrial area completely surrounded by environmentally degraded parcels. The setting of the Site is significant in that the potential for successfully establishing and maintaining a healthy wetland habitat on a long-term basis, either on-Site or in the immediate vicinity, is low. The only source of high quality water to the created or enhanced wetland would be rain water landing directly upon the wetlands. Water quality of the Christina River in the vicinity of the Port of Wilmington is generally poor.

Therefore, creation or enhancement of wetlands to compensate for the loss due to implementation of this remedy would be accomplished off-Site, preferably in the Christina River watershed, at a specific location to be determined in consultation with federal, state and local authorities.

Operation and maintenance would be performed to ensure the integrity of the asphalt cap and minimize erosion of soil cover. On-Site maintenance activities would include periodically resealing and repairing cracks in the cap. Long-term chemical monitoring would be required to confirm that the containment components are preventing off-Site migration of Site-related contaminants. The monitoring program would include chemical monitoring of sediment and surface water in the I-495 drainage ditch, the Lobdell Canal and the Christina River. The specific monitoring program would be developed during the Remedial Design. The monitoring plan would establish chemical-specific trigger values that would lead to the incorporation of biological testing methods. Off-Site activities would include appropriate monitoring and/or maintenance of the created/enhanced wetland.

The deeds would be restricted to ensure the lagoon and marsh property is not used in a manner inconsistent with the remedy.

Alternative LM-4A: Backfill Lagoon and North/Central Marsh, Cap Lagoon with Paved Surface, Wetlands Compensation, Long-Term Monitoring of Southern Marsh, Institutional Controls

Capital Cost:	$5,400,000
Annual O&M Cost:	$97,000
Total Present Worth Cost:	$7,100,000
Time to Implement:	10 months

This alternative is based upon Alternatives LS-6 and MS-2 in the FS with modifications by EPA.

This alternative is the same as Alternative LM-4 except the southern marsh would not be actively remediated.

Within the marsh ecosystem, previous investigations have determined the north and central marsh area (approximately 3.2 acres) to be: 1) chemically degraded by high concentrations of multiple hazardous substances; and 2) toxic to test organisms. The southern marsh (approximately 2 acres) characterized by samples collected near the Lobdell Canal is also chemically degraded; however, the concentrations were lower, as was demonstrated toxicity to test organisms. Actual delineation between the north/central and southern marsh areas would be accomplished with an intensive sampling program focused along the conceptual interface between the two areas. The sampling program would include at least 2 rounds of sample collection on a 50-feet grid. Sediment samples would be evaluated by both chemical analysis and bioassay tests. Applicable action levels would be determined during remedial design

activities in consultation with federal and state natural resource trustees.

In this alternative, the on-Site lagoon and the north and central marsh areas would be filled in with clean backfill to the surrounding grade. The lagoon area would be capped with a wear surface, such as asphalt pavement, suitable for use in an industrial yard. Storm water management structures would be installed as appropriate to comply with Delaware storm water control regulations. A monitoring program that includes both quantitative chemical testing and exposing test organisms to marsh sediment (bioassay tests) would be designed and implemented to ensure that the marsh is safe for wildlife.

Similar to alternatives which include loss of wetland areas associated with the on-Site lagoon, the elimination of the north/central marsh as a wetland would require compensation by creating an equal value of healthy wetland habitat, for the loss of approximately 5 acres and the reduced future productivity of approximately 2 acres of southern marsh wetlands, at an alternate location.

The remaining components of the remedy would be the same as those described in Alternative LM-4.

C. Alternatives for Ground Water

Alternative G-2: Institutional Controls

Capital Cost:	$36,000
Annual O&M Cost:	$46,000
Total Present Worth Cost:	$740,000
Time to Implement:	Immediate

This alternative is based upon Alternative GC-2 in the FS with modifications by EPA.

Institutional controls would be put in place in conformance with the ground water management zone ("GMZ") established by DNREC encompassing the Halby Chemical Site[4]. The ground water management zone eliminates the potential for future exposure to ground water by ensuring that no public or domestic water supply wells are permitted in any aquifer beneath the Halby Chemical and Potts Property State Superfund Sites. Under this alternative, EPA would establish deed restrictions to further prevent the installation of wells on the parcels comprising the Site. Monitoring of ground water in the Columbia, Upper Potomac and Lower Potomac Aquifers would be conducted to track Site-related contamination over time. It is anticipated that an additional 4 monitoring wells would be installed in new locations to optimize the ground water monitoring program. In accordance with DNREC's GMZ, installation of monitoring wells may

[4] Delaware DNREC formally established a ground water management zone encompassing the Halby Chemical Site, the Potts Property State Superfund Site and the Port of Wilmington and environs (February 5, 1998).

be approved following joint review and approval of DNREC's Division of Water Resources and Division of Air and Waste Management.

Alternative G-2 recognizes that, while the Halby Chemical Site is a source of contaminants to the underlying Columbia and Upper Potomac Aquifers, the larger picture is that there are multiple significant sources of contamination to ground water. Based on preliminary investigations conducted under the direction of DNREC, the adjacent Potts Site includes a landfill containing several hundred thousand cubic yards of waste soil from an ore processing plant. The soil is landfilled to a depth below the water table and contains elevated levels of inorganic hazardous substances. As a result, the ground water in the area should be evaluated on a larger scale as engineering controls implemented on a parcel-by-parcel basis would not likely lead to environmental benefit. If the on-going Remedial Investigation at the Potts Property State Superfund Site being conducted in accordance with the Delaware Hazardous Substance Cleanup Act ("HSCA") determines that the intermingled ground water contamination presents an unacceptable risk to human health or the environment downgradient of the Potts Site, DNREC will evaluate the options and propose a Plan of Remedial Action which would address ground water.

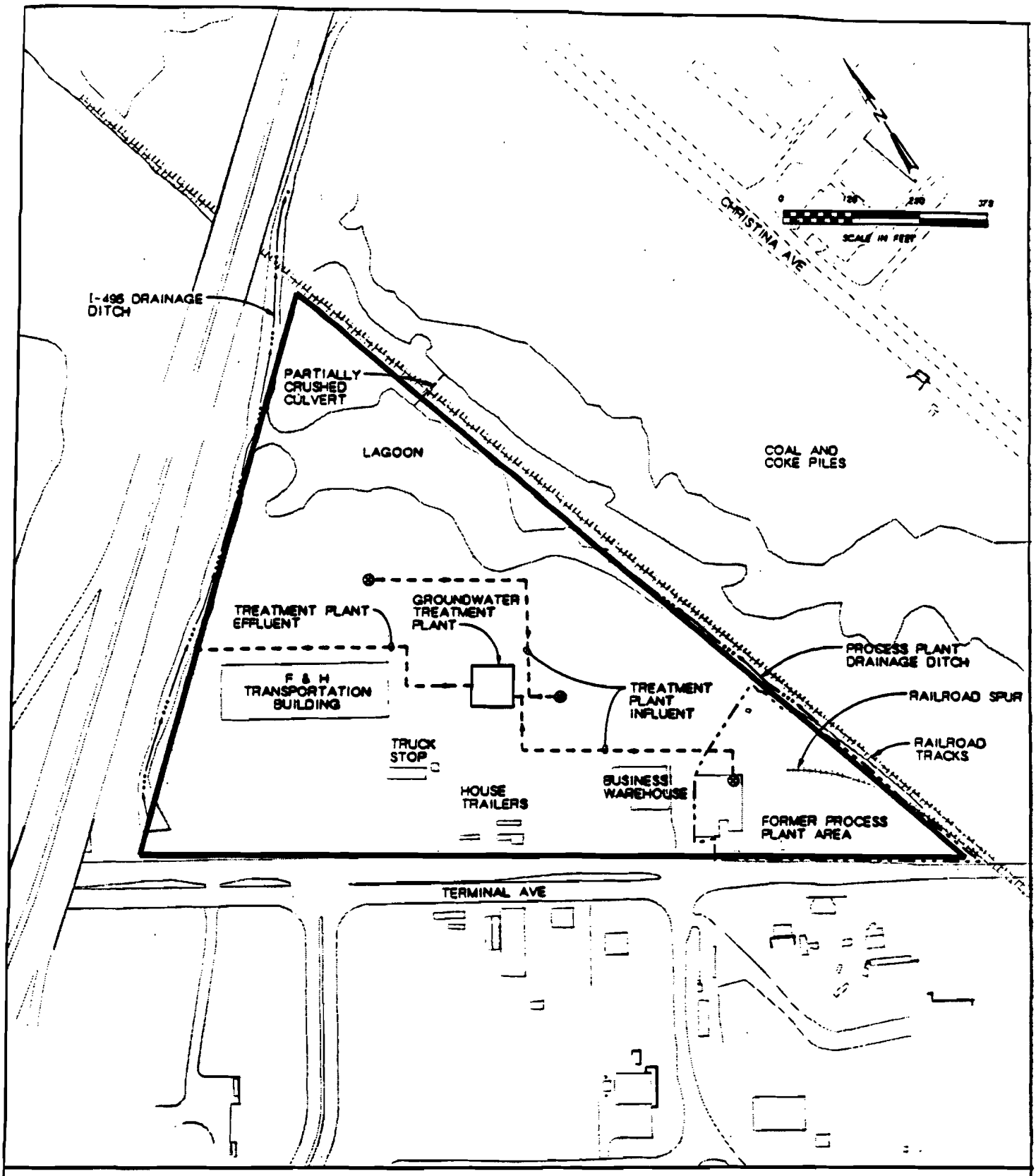
Alternative G-3: Slurry Wall for Columbia Aquifer, Institutional Controls for Upper Potomac Aquifer

Capital Cost:	$3,800,000
Annual O&M Cost:	$300,000
Total Present Worth Cost:	$8,400,000
Time to Implement:	10 months

This alternative is based upon Alternative GC-3 in the FS with modifications by EPA.

A slurry wall would be constructed around the perimeter of the Site, enclosing the horizontal limit of contaminants within the Columbia Aquifer. The estimated location of the slurry wall is shown in Figure 12. The primary purpose of the slurry wall is to isolate on-Site soil containing hazardous constituents in the saturated and unsaturated portion of the Columbia Formation from the surrounding subsurface environment. It is estimated that a slurry wall 4,200 feet long by 30 feet deep would be required. The slurry wall along the eastern boundary of the Site would be physically constrained by the presence of railroad tracks. Most of the carbon disulfide DNAPL would be enclosed by the slurry wall, however, a stretch of the wall may pass through carbon disulfide contaminated soil. The 36-inch thick slurry wall would be constructed of a soil-bentonite mix, or may include an integral geomembrane, and would have an in-place permeability of less than 1×10^{-7} cm/sec. The slurry wall would tie-in to the Potomac clay at its base.

Several geophysical investigations would be performed prior to design of the slurry wall configuration, including, but not limited to: depth to Potomac clay along slurry wall alignment; investigation of chemical compatibility of bentonite design mix and Site-specific contaminants;



LEGEND

- DRAINAGE DITCH
- SITE BOUNDARY
- FORMER PROCESS PLANT AREA BOUNDARY
- SLURRY WALL
- EXTRACTION WELL
- GROUNDWATER TREATMENT PIPING

Figure 12
ALTERNATIVE G-3
SLURRY WALL FOR COLUMBIA
Halby Chemical Site

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and a plan to accommodate utilities servicing the businesses located on-Site.

This alternative includes pumping water from the interior of the slurry wall to maintain a positive hydraulic gradient into the enclosed area. Approximately 5 to 10 gallons per minute would be continuously removed to keep pace with the combination of ground water leaking across the slurry wall and the local precipitation. It is anticipated that an on-Site water treatment plant would be constructed and operated to treat this ground water prior to its discharge to the I-495 drainage ditch. The water treatment facility effluent would meet the contaminant-specific concentrations necessary for permitted discharge to a surface water body. In addition to these numeric criteria, the effluent would meet the chronic freshwater State Ambient Surface Quality Standards and Federal Ambient Water Quality Criteria narrative criteria which prohibit discharge of treated water that is toxic to aquatic organisms. Ground water monitoring would be included to track the effectiveness of the remedy.

Similar to Alternative G-2, institutional controls would be put in place in conformance with the GMZ established by DNREC encompassing the Halby Chemical Site. EPA would establish deed restrictions to further prevent the installation of wells on the parcels comprising the Site. Monitoring of ground water in the Columbia, Upper Potomac and Lower Potomac Aquifers would be conducted to track Site-related contamination over time.

Alternative G-4: Extract and Treat Ground Water from Columbia and Upper Potomac Aquifers, Discharge Treated Water to Surface Water, Institutional Controls

Capital Cost:	$4,600,000
Annual O&M Cost:	$490,000
Total Present Worth Cost:	$12,200,000
Time to Implement:	18 months

This alternative is based upon Alternative GC-4 in the FS with modifications by EPA.

A ground water extraction and treatment system would be designed and installed to contain the contaminated ground water at the Site and prevent off-Site migration of contamination. Approximately six 6-inch diameter extraction wells would be installed in the Columbia Aquifer to an estimated depth of 30 feet; another 6 wells would be installed into the Upper Potomac Aquifer to an estimated depth of 70 feet. The wells would intercept ground water migrating through the Site and prevent contaminated ground water from escaping the Site boundaries. It is estimated that the system would withdraw up to 25 gallons per minute. The actual number and location of extraction wells would be determined during the Remedial Design.

It is anticipated that an on-Site water treatment plant would be constructed and operated to treat this ground water prior to its discharge to the I-495 drainage ditch. The water treatment facility effluent would meet the contaminant-specific concentrations necessary for permitted discharge to a surface water body. In addition to these numeric criteria, the effluent would meet the State

Ambient Surface Quality Standards and Federal Ambient Water Quality Criteria narrative criteria which prohibit discharge of treated water that is toxic to aquatic organisms.

The conceptual ground water treatment system would include the following processes in sequence: flow equalization; a metal precipitation unit to extract high concentrations of inorganic contaminants; an air stripping system to remove the carbon disulfide and, if necessary, ammonia; ion exchange for arsenic and heavy metals; UV/hydrogen peroxide oxidation for cyanide/thiocyanate; and sludge dewatering, granulated activated carbon for treatment of off-gas from air stripper. The actual components of the system would be determined during the design to achieve surface water discharge requirements.

Operation and maintenance activities would include, but not be limited to, operation of the plant, maintaining extraction wells with periodic cleaning of well screens, periodic ground water level and chemical measurements to confirm that Site ground water is being captured, and routine chemical analyses of plant effluent with quarterly bioassay tests to confirm that the discharge meets State requirements. The net present worth cost estimate was based on a 30-year operation period, however, operation is expected to continue beyond 30 years.

Based on preliminary investigations conducted under the direction of DNREC, the adjacent Potts Site includes a landfill containing several hundred thousand cubic yards of waste soil from an ore processing plant. The soil is landfilled to a depth below the water table and contains elevated levels of inorganic hazardous substances. Therefore, even with this ground water pump and treat option at the Halby Chemical Site, institutional controls similar to Alternative G-2 would be put in place in conformance with the GMZ established by DNREC encompassing the Halby Chemical Site. EPA would establish deed restrictions to further prevent the installation of wells on the parcels comprising the Site, other than those wells necessary to implement Alternative G-4. Monitoring of ground water in the Columbia, Upper Potomac and Lower Potomac Aquifers would be conducted to track Site-related contamination over time.

Alternative G-5: Extract and Treat Ground Water from Columbia and Upper Potomac Aquifers, Reinject to Ground Water, Institutional Controls

Capital Cost:	$10,300,000
Annual O&M Cost:	$1,300,000
Total Present Worth Cost:	$30,200,000
Time to Implement:	18 months

This alternative is based upon Alternative GC-5 in the FS with modifications by EPA.

This alternative includes five extraction wells in the Columbia Aquifer and five extraction wells in the Upper Potomac Aquifer at the same depths as those described in Alternative G-4. However, this alternative adds 14 additional wells in each of these water-bearing units for reinjection of the treated ground water. It is estimated that the system would withdraw up to 100

gallons per minute. The actual number and location of extraction/reinjection wells would be determined during the Remedial Design. The treatment standards for reinjection to the ground water would be based on drinking-water standards or risk-based concentrations if primary or secondary MCLs are not available or protective. The ground water system would be a larger version of the system described as part of Alternative G-4.

The injection wells allow water circulation through the Columbia and Upper Potomac water-bearing units at a significantly higher rate than in Alternative G-4. By injecting the treated ground water both upgradient and downgradient of the Site, ground water extraction rates can be increased and a hydraulic barrier created to prevent migration of contaminated ground water off-Site. The increased water extraction rate may decrease the time necessary to remediate the aquifer. The reinjection system may prevent the dewatering of the lagoon and marsh should the no action alternative be selected for the surface water bodies.

Institutional controls and ground water monitoring provisions would be the same as Alternative G-4.

D. Alternatives for DNAPL

Alternative D-2: Institutional Controls

Capital Cost:	$0
Annual O&M Cost:	$0
Total Present Worth Cost:	$0
Time to Implement:	Immediate

This alternative is the same as Alternative G-2 above which is based upon Alternative GC-2 in the FS with modifications by EPA.

Natural chemical and physical properties of carbon disulfide (i.e., carbon disulfide is not water soluble) have resulted in the compound not moving far from the point of original release to the environment. Institutional controls would be put in place in conformance with the GMZ established by DNREC encompassing the Halby Chemical Site. The ground water management zone eliminates the potential for future exposure to ground water by ensuring that no public or domestic water supply wells are permitted in any aquifer beneath the Halby Chemical and Potts Property State Superfund Sites. Under this alternative, EPA would establish deed restrictions to further prevent the installation of wells on the parcels comprising the Site. Monitoring of ground water in the Columbia, Upper Potomac and Lower Potomac Aquifers would be conducted to track Site-related contamination over time (estimated cost of monitoring program is recorded in alternatives G-2 through G-5).

The purpose of the GMZ is to provide continued assurance through institutional controls that future risk pathways are addressed.

Worker Safety: Worker safety requirements, including those pertaining to the handling of hazardous substances, set forth in 29 C.F.R. § 1910, are applicable to each alternative requiring physical contact with soil, sediment, ground water or residual sludge from ground water treatment.

Fugitive dust emissions generated during remedial activities will be controlled in order to comply with fugitive dust regulations in the federally-approved State Implementation Plan ("SIP") for the State of Delaware and the National Ambient Air Quality Standards for Particulate Matter in 40 C.F.R. § 50.6

Location-Specific ARARs

Protection of Wetlands: The remedial alternatives for the lagoon and marsh must meet the substantive requirements of Section 404(b)(1) of the Clean Water Act. Unavoidable impacts to wetlands must be mitigated. In the event that the selected alternative includes filling in on-Site wetlands, the creation/enhancement of off-Site replacement wetlands would be performed to restore the natural function and value of the wetland habitat.

In summary, all alternatives would be implemented so as to meet their respective applicable or relevant and appropriate requirements of federal and state environmental laws.

C. Long-Term Effectiveness for Meeting Remedial Action Objectives and Permanence

Soil Alternative S-2 provides a moderately permanent and effective long-term remedy by requiring regular and continuing maintenance of the cap. The construction of the cap would eliminate the risk due to direct contact with contaminants at the Site and would reduce mobility of contaminants in soil above the water table to the ground water. The degree of long-term effectiveness and permanence increases with Alternative S-3 which would stabilize contaminants in the soil and further reduce their migration into the ground water. By immobilizing the contaminants through treatment, Alternative S-3 relies less on continued maintenance of the cap to achieve long-term effectiveness and permanence. Alternatives S-4 and S-5 would remove contaminants from the Site, further increasing the long-term effectiveness and permanence.

Lagoon and Marsh Alternatives LM-2 and LM-2A have the potential to provide an effective remedy on a long-term basis. Some technical uncertainty exists in predicting the success of establishing a high quality wetland habitat upon a geomembrane. Altering the natural hydrology should not be a problem, as the project would be designed so that tidally driven surface water would provide routine water flow to the system. The lagoon and marsh are completely surrounded by industrial properties which have been chemically degraded due to past use. Even

if these areas can be isolated from the underlying contaminated ground water, it is likely that the new wetlands will be chemically degraded over time due to the surrounding land use. Alternative LM-4A would have a high degree of long-term effectiveness because potential exposure to the most contaminated sediment, located in the north/central portion of the wetland would be eliminated. The likelihood that the quality of the southern portion of the marsh would increase as natural processes wash the contaminants from the marsh bottom is uncertain.

Alternatives LM-3 and LM-4 have a greater potential for long-term effectiveness and permanence by preventing people and ecological receptors from coming into contact with contaminated sediment. Compensatory wetland habitat would be created or restored at an off-Site location so that exposure of wildlife to Site-related contaminants would not be an issue. Alternative LM-3 would have the greatest degree of long-term permanence as the contaminated sediment would be stabilized prior to backfilling and capping.

Ground Water and DNAPL Alternatives G-2 through G-5 have a high degree of long-term effectiveness primarily due to the institutional controls included in each of the alternatives. The nature of the ground water contamination, including both carbon disulfide DNAPL and the continued migration of various metals from vast quantities of soil which were historically deposited on the Halby Chemical Site and the adjacent Potts Property State Superfund Site, makes successful ground water restoration immediately downgradient of the Site property boundary infeasible. Alternatives G-4, G-5 and the DNAPL Alternatives D-3 and D-4 would slowly extract contaminant mass from the ground water. Nevertheless, the ground water beneath the Halby Chemical Site or the downgradient Potts Property State Superfund Site would not be fit for human consumption. The Feasibility Study estimated that between 50 and 300 years would be necessary to achieve drinking water standards if no additional contaminants migrate to the ground water. Thus, while Alternatives G-2 through G-5 do provide a high degree of long-term effectiveness, the long-term effectiveness of these alternatives depend upon the institutional controls included in each alternative.

D. Reduction of Toxicity, Mobility and Volume

Section 121(b) of CERCLA, 42 U.S.C. § 9621(b), establishes a preference for Remedial Actions which include treatment that permanently and significantly reduces the toxicity, mobility, or volume of contaminants.

Soil The principal threat identified at the Site presented by high concentrations of carbon disulfide in soil extending from the point that waste water was discharged from the chemical production facility to the lagoon was eliminated. EPA expedited the clean-up by addressing the carbon disulfide through an immediate removal action completed in January 1998. The carbon disulfide was treated in-place by chemical oxidation. The alternatives evaluated in this Record of Decision address the contaminants which remain now that the carbon disulfide response action has been completed.

Only Alternatives S-3 and S-4 include measures to reduce the mobility of Site contaminants through treatment. Alternative S-4 and S-5 would reduce the volume of contaminants from the Site by removing them. Both S-4 (Soil Washing) and S-5 (Off-Site Disposal) would likely require pre-treatment of materials removed from the Halby Chemical Site prior to land disposal. Alternative S-3 requires use of a treatment technology (i.e., stabilization) which would reduce the mobility of the contaminants present in the soil. Alternative S-2 reduces mobility by requiring a cap to be constructed over the contaminated soil which would reduce infiltration of water and surface erosion.

Lagoon and Marsh Only Alternatives LM-2A and LM-3 include measures to reduce the mobility of Site contaminants through treatment. Both Alternative LM-2A and LM-3 require use of a treatment technology (i.e., stabilization) which would reduce the mobility of the contaminants present in the sediment. In addition, Alternative LM-2 would likely require stabilization of excavated sediment prior to disposal in an off-Site landfill. Alternatives LM-4 and LM-4A reduce mobility of contaminants in sediment by capping the lagoon and covering the marsh with clean soil thereby reducing migration of contaminated sediment off-Site though surface erosion.

Ground Water Alternatives G-3, G-4, G-5 and the DNAPL Alternatives D-3 and D-4 would slowly extract contaminant mass from the ground water thereby reducing the toxicity, mobility, and volume of contaminants in the ground water through treatment. However, even the combination of the most aggressive treatment alternatives (i.e., G-5 and D-3) are not expected to restore ground water beneath the Site to use for human consumption. Alternatives D-2 and G-2 do not reduce the toxicity, mobility or volume of contaminants through treatment.

E. Short-Term Effectiveness

Soil Alternative S-2 offers the greatest short-term effectiveness, as excavation and handling of contaminated soil would be limited to the small-scale consolidation of low level soil-contamination from the adjacent residential parcel. Alternative S-2 would also have the shortest implementation time. Alternative S-3 would achieve very good short-term effectiveness, especially if the stabilization component could be achieved *in situ* to minimize exposure of construction workers to Site contaminants during the soil mixing process. The need to conduct treatability studies to develop proper reagent mixes for various areas of the Site may delay the implementation time of Alternative S-3. Alternative S-5 involves the excavation and off-Site disposal of contaminated soil and could pose an increased short-term health risk to on-Site workers and/or trespassers during earth-moving activities. Alternative S-4 would have the lowest short-term effectiveness as excavation and handling of the contaminated soil would be significant, leading to the increased potential for exposure of workers to Site-related contaminants. Although risks associated with air borne contaminants can be controlled, the alternatives which require large scale excavation will likely lead to odors which may be difficult to control and lead to community acceptance issues. Alternative S-4 and S-5 would pose an incremental increase in risk due to potential for traffic accidents while transporting the contaminated material to approved treatment, storage and/or disposal facilities. Alternative S-4

would likely require the most time to implement. All short-term risks to Site workers would be minimized using standard safety measures.

Lagoon and Marsh Alternatives LM-4 and LM-4A offer the greatest short-term effectiveness. Alternatives LM-4 and LM-4A would have the shortest implementation times and are the only alternatives that do not require handling of contaminated sediment. Alternative LM-3 has good short term effectiveness, especially if the stabilization could be accomplished without first excavating the contaminated sediment. *In situ* stabilization would reduce the potential for exposure of Site workers to contaminated sediment. The treatability study required to develop the best reagent mix to immobilize the contaminants will extend the time required to implement the sediment stabilization. Alternatives LM-2 and LM-2A would achieve moderate short-term effectiveness as Site workers would have increased risk of exposure during sediment excavation, on-Site handling required to stabilize and/or solidify the wet sediment, and during installation of the geomembrane in the degraded lagoon.

Ground Water Alternative G-3 would achieve moderate short-term effectiveness as Site workers would be at increased risk of exposure to contaminated soil and ground water during excavation and soil mixing involved with slurry wall installation. The most significant hazard would be presented during intrusive activities in the area of carbon disulfide contamination. Alternatives G-4 and G-5 would achieve good short-term effectiveness as there would be little potential for significant exposure to contaminants during installation of recovery wells or construction of the on-Site water treatment plant. Construction of the recovery well system and water treatment plant would require approximately one year. Potential for significant exposure to Site-related contaminants during the operation of the pump and treat system would be minimal. Adding either Alternative D-3 or D-4, targeting removal of carbon disulfide DNAPL, to any of the other alternatives would greatly increase the risk of exposure and the hazard associated with handling, storing, transporting and/or treating materials on the Site. Carbon disulfide is highly volatile, extremely flammable and toxic at low levels. The carbon disulfide would pose a greater risk to human health once removed from the subsurface than it does in its current state. Alternative G-2 would pose the lowest potential for adverse impacts to human health and the environment during implementation as a ground water management zone is in place, therefore no time delay for implementation is incurred. Since no actual construction would take place, Site workers would not be at risk of increased exposure.

F. Implementability

This evaluation criterion addresses the difficulties and unknowns associated with implementing the cleanup technologies associated with each alternative, including the ability and time necessary to obtain required permits and approvals, the availability of services and materials, and the reliability and effectiveness of monitoring.

Soil The installation of a cap in Alternative S-2 utilizes well-known construction methods. Necessary services and materials are readily available.

Alternative S-3 would require stabilization of contaminated soil prior to construction of a cap. Stabilization is a technology which is commonly used to immobilize inorganic contaminants in soil; nevertheless, additional studies would be required to determine appropriate reagent/additive, the method of application, and the limits of treatment. Verification of the success of the stabilization process would require a detailed quality assurance plan. The stabilization technology used in Alternative S-3 is more complicated to implement than the cap alone.

Alternative S-5 requires excavation of contaminated soil, which is a relatively straightforward process. As with Alternatives S-3 and S-4, additional sampling and waste characterization will be necessary to more specifically determine the location and volume of soil requiring treatment. In addition, waste characterization will determine pre-treatment requirements, if necessary, and the appropriate type of landfill(s) for disposal. Appropriate landfill facilities with capacity for the contaminated soil should be available within several hundred miles from the Site; however, transportation costs may be significant.

Alternative S-4 would be the most difficult to implement due to the combination of technologies used and the uncertainties involved with each. Both soil washing and stabilization would have to be evaluated through treatability testing. Soil washing is generally considered to be technically inappropriate if the bulk of contaminants are already located within fine-sized particulate matter. This could be significant with the relatively large volume of contaminated former lagoon sediment.

Worker exposure and protective equipment requirements for construction activities can be readily achieved for all of the alternatives. Alternatives S-3, S-4 and S-5 include intrusive activities and would provide for monitoring the air for carbon disulfide. All alternatives would provide appropriate measures to control dust.

Lagoon and Marsh Alternatives LM-4 and LM-4A would utilize well-known construction methods. Necessary services and materials are readily available for the backfilling and capping of the lagoon and marsh. The low bearing capacity of the lagoon material must be addressed in the design. The use of geosynthetics to provide a base upon which fill can be placed over an unstable subsoil may be necessary, but is well-understood technically. Locating a suitable off-Site location for creation or restoration of replacement wetland habitat would require significant effort and coordination with appropriate regulatory agencies.

The implementation of Alternative LM-3 would be similar to Alternative LM-4 with the additional technical complexities associated with the effective stabilization of contaminated sediment. Alternative LM-2 would also include the complications associated with stabilization of contaminated sediment. Alternatives LM-2 and LM-2A include excavation of sediment and installation of a geomembrane liner. Each of these subtasks would introduce significant technical challenges including establishment of suitable sub-base stability and management of surface water during the liner installation. The re-establishment of a functioning wetland habitat would require a specialty contractor. Significant post-construction monitoring and maintenance of the wetland would be required.

Ground Water and DNAPL Alternatives G-3 and D-3 would utilize slurry walls, a well-understood practice. A treatability study would be utilized to select an appropriate reagent/additive for Site-specific conditions and chemical compatibility. Hydrogeologic conditions are appropriate for application of this technology. Current and future utilities servicing the many business concerns located on the Site would be re-routed. Special coordination with the railroad and the utility companies would be required to place the slurry wall as close to the railroad tracks and high power line as technically practicable, while taking safety concerns into account.

Ground water extraction technologies included in Alternatives G-3 through G-5 are proven and can be readily implemented. Ground water modeling would be conducted to select the most efficient locations for extraction well placement. The current and future use of the property for industrial use including truck traffic would be considered prior to final placement of extraction wells. Pipes conveying recovered ground water to the on-Site water treatment plant would be constructed below grade in a manner to withstand loads consistent with truck traffic. Materials and services are readily available.

The high iron, manganese and sulfate concentrations in the extracted ground water could complicate the pump and treat process because of the potential of fouling the well screens, clarifier, filter, and air stripper. The treatment plant required to treat the array of contaminants in the ground water would require several coupled water treatment technologies making the overall process technically complex. Nevertheless, vendors capable of constructing and operating such a system are readily available.

Alternatives D-3 and D-4 include DNAPL extraction and treatment which is more difficult to implement. Incremental reduction of carbon disulfide mass in the Columbia formation is possible, however, complete removal of the DNAPL is not technically feasible. Because of its viscosity and the complex hydrogeology, it may be difficult to locate a significant pool of DNAPL. If a pool of carbon disulfide is found, it would be difficult to extract in free phase. Special design considerations would be necessary to ensure the safety of workers due to the volatility and flammability of carbon disulfide. A submersible pump which utilizes nitrogen could be used to reduce the potential for an explosion. The extracted carbon disulfide would be stored in a special tank with a water and/or nitrogen blanket before it is disposed of off-Site. The technical implementation of D-3 is theoretical at this point because an effective and acceptable surfactant must yet be identified. Regulatory approval of surfactant injection may be difficult.

Alternatives G-2 and D-2 could be readily implemented. DNREC has designated ground water management zones to prevent the installation of water supply wells in chemically degraded aquifers at this and other locations. EPA has successfully implemented deed restrictions on Superfund parcels at other locations.

G. Cost

Evaluation of costs of each alternative generally includes the calculation of direct and indirect

capital costs and the annual operation and maintenance ("O&M") costs, both calculated on a present worth basis. An estimated capital, annual O&M and total present worth cost for each of the Alternatives has been calculated for comparative purposes and is presented in Table 3.

Direct capital costs include costs of construction, equipment, building and services, and waste disposal. Indirect capital costs include engineering expenses, start-up and shutdown, and contingency allowances. Annual O&M costs include labor and material; chemicals, energy, and fuel; administrative costs and purchased services; monitoring costs; cost for periodic Site review (every five years); and insurance, taxes, and license costs. For cost estimation purposes, a period of 30 years has been used for O&M. In reality, maintenance of a site with waste left in place would be expected to continue beyond this period. Similarly, the actual duration of operation for the ground water extraction and treatment system would depend on the ability to successfully limit off-Site migration of Site-related contaminants. The actual cost for each alternative is expected to be in a range from 50 percent higher than the costs estimated to 30 percent lower than the costs estimated. The evaluation was based on the FS cost estimates, as modified by EPA.

H. State Acceptance

The State of Delaware has provided support to EPA throughout the conduct of the RI/FS and does concur with the Selected Remedy (Alternatives S-2, LM-4, G-2 and D-2).

I. Community Acceptance

Pursuant to CERCLA § 113(k)(2)(B)(i)-(v), EPA released for public comment the administrative record including the final RI/FS reports and the Proposed Plan setting forth EPA's preferred alternative for the Halby Chemical Site on July 30, 1997. EPA made these documents available to the public in the Administrative Record located at the EPA Region III offices, Philadelphia, PA, and at the Wilmington Institute Library in Wilmington Delaware. The notice of availability of these documents was published in *The Wilmington News Journal* on July 30, 1997.

A public comment period was held from July 30, 1997 to September 29, 1997. In August 1997 EPA issued a Fact Sheet announcing the availability of the Proposed Plan and public meeting. The August 1997 Fact Sheet discussed EPA's Preferred Alternative, as well as other alternatives evaluated by EPA and solicited comments from all interested parties. On August 18, 1997, EPA and DNREC conducted a public meeting at the DeLaWarr State Service Center in New Castle, Delaware to discuss the Proposed Plan. At this meeting, representatives from EPA answered questions about conditions at the Site and the remedial alternatives under consideration. In addition, EPA conducted a Halby Chemical briefing with the Wilmington Local Emergency Planning Committee ("LEPC") on September 19, 1997 and participated in a Superfund Workshop jointly sponsored by the Wilmington and New Castle County LEPCs and open to the public, on September 23, 1997.

Table 3 Summary of Estimated Costs			
	Capital Cost	Annual O&M Cost	Present Worth
Soil			
Alternative S-2	$1,550,000	$8,100	$1,700,000
Alternative S-3	$16,000,000	$8,100	$16,100,000
Alternative S-4	$27,250,000	$0	$27,300,000
Alternative S-5	$8,100,000	$0	$8,100,000
Lagoon and Marsh			
Alternative LM-2	$21,500,000	$116,000	$23,800,000
Alternative LM-2A	$17,500,000	$116,000	$19,300,000
Alternative LM-3	$43,900,000	$30,000	$44,600,000
Alternative LM-4	$6,640,000	$30,000	$7,300,000
Alternative LM-4A	$5,400,000	$97,000	$7,100,000
Ground Water			
Alternative G-2	$36,000	$46,000	$740,000
Alternative G-3	$3,800,000	$300,000	$8,400,000
Alternative G-4	$4,600,000	$490,000	$12,200,000
Alternative G-5	$10,300,000	$1,300,000	$30,200,000
DNAPL			
Alternative D-2	$0	$0	$0
Alternative D-3	$1,200,000	$4,700,000	$54,200,000
Alternative D-4	$510,000	$660,000	$10,700,000

* See detailed Alternative Cost Estimate in Administrative Record at pages 307340-307377

The responses to all comments received during the public comment period are included in the Responsiveness Summary, which is included in this ROD.

In summary, EPA believes the Selected Remedy provides the best balance of the nine criteria among the alternatives.

IX. THE SELECTED REMEDY; DESCRIPTION AND PERFORMANCE STANDARDS

A. General Description of the Selected Remedy

EPA carefully considered state and community acceptance of the remedy prior to reaching the final decision regarding the Selected Remedy.

The Agency's Selected Remedy is the combination of Alternatives S-2, LM-4, G-2, and D-2: *Cap Soil with a Paved Surface, Surface Water Runoff Controls, Backfill and Cap Lagoon and Marsh, Replace Wetlands at an Off-Site Location, Institutional Controls for Ground Water, and Long-Term Monitoring.* Based on current information, this alternative provided the best balance among the alternatives with respect to the nine criteria EPA uses to evaluate each alternative.

The Selected Remedy consists of the following components:

Soil

Alternative S-2: Paved Surface Cap, Surface Water Runoff Controls, Long-term Monitoring, and Institutional Controls

- Cover the areas of the Site where soil exceeds 38 mg/kg arsenic with a paved cap.
- Excavate soil on the adjacent residential property that exceeds 14 mg/kg arsenic and combine with the contaminated soil under the cap.
- Backfill the residential property with clean soil, cover with six inches of topsoil and re-establish vegetation.
- Monitor gas in the area of the carbon disulfide treatment zone; install a gas collection system, if necessary.
- Install a system to control both surface water and soil erosion.
- Conduct long-term monitoring to ensure the integrity of the cap.
- Implement deed restrictions.

Lagoon and Marsh

Alternative LM-4: Backfill Contaminated Wetlands, Pave Lagoon Surface, Wetlands Compensation, and Institutional Controls

- Drain the lagoon and marsh, excavate the I-495 drainage ditch sediments, and place the sediments in the lagoon/marsh area.

- Backfill and level the lagoon and marsh with clean soil.
- Cap the lagoon area with a paved surface; cover the marsh area with topsoil and establish vegetation.
- Utilize a mobile water treatment plant to treat water taken from the lagoon and marsh, if necessary.
- Create a new wetlands area at an off-Site location, equivalent in function and value to the approximately 7 acres of the on-Site lagoon and marsh areas to be eliminated.
- Conduct long-term monitoring and maintenance activities.
- Implement deed restrictions.

Ground Water, Including the Dense Non-Aqueous Phase Liquids
Alternatives G-2 and D-2: Institutional Controls

- Implement deed restrictions consistent with DNREC's ground water management zone to provide additional continued assurance that public or domestic water supply wells are not permitted to draw water from aquifers affected by the Site.
- Conduct ground water monitoring to track Site-related contamination.

The cumulative estimated cost of implementing Selected Remedy is:

Capital Cost:	$8,225,000
Annual O&M Cost:	$84,100
Total Present Worth Cost:	$9,740,000

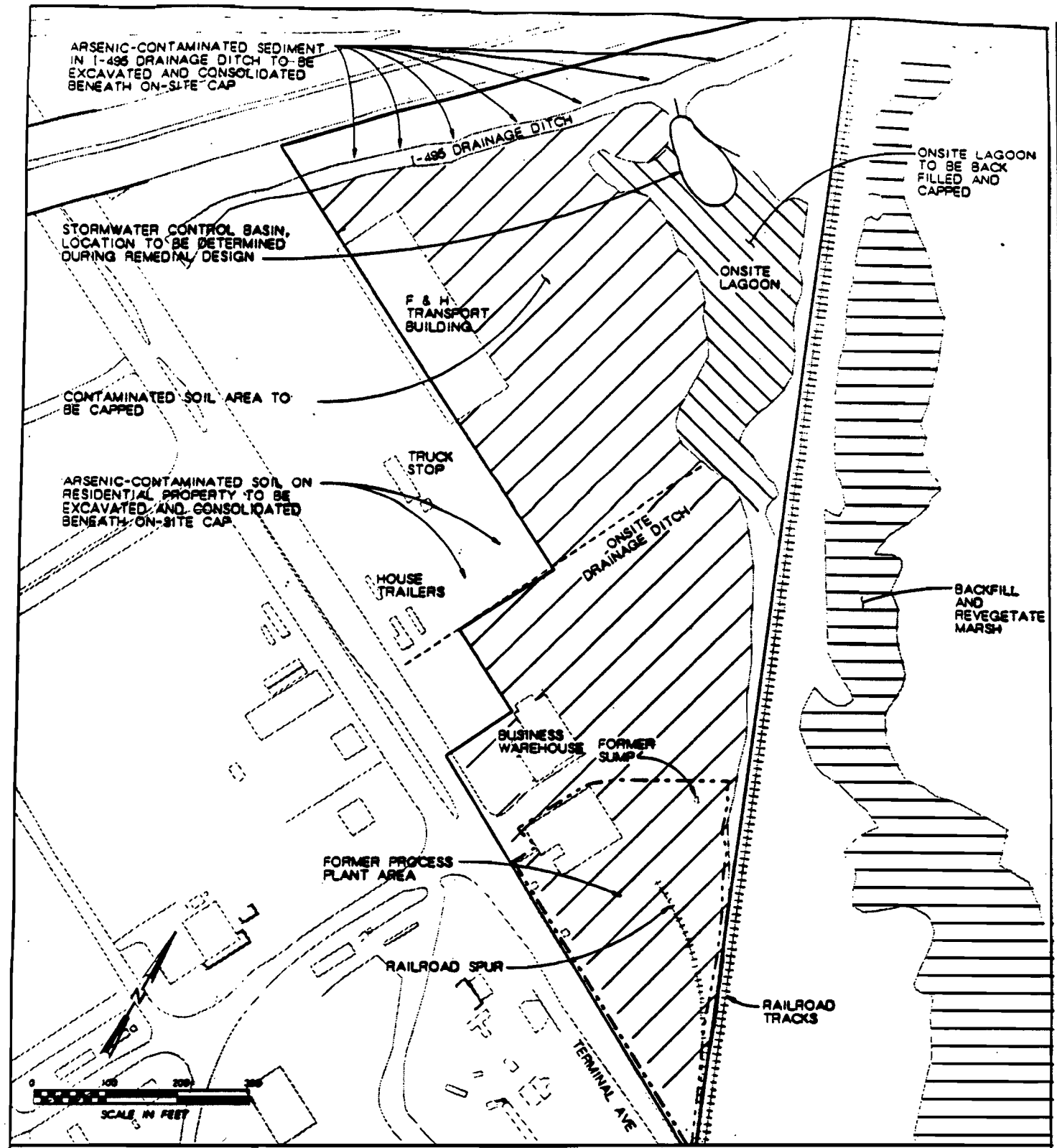
Figure 13 presents an overview of the site-wide Selected Remedy. The Selected Remedy must be implemented so as to comply with the applicable or relevant and appropriate laws identified in Table 4. Each component of the Selected Remedy and its Performance Standards are described below.

B. Description and Performance Standard(s) of Each Component of the Selected Remedy

Soil

1. Cap Contaminated Soil with Paved Surface

A cap with a paved surface designed to withstand loads consistent with industrial land use will be installed over the area of the Site where surface and/or subsurface soil exceed cleanup standards. The cap will prevent direct contact with, and inhalation of, potentially harmful dust generated from contaminated soil. The cap will also prevent off-Site migration of contaminated soil and reduce the amount of precipitation which infiltrates through contaminated soil above the water table and into the ground water.



LEGEND

- HALBY CHEMICAL SITE
- FORMER PROCESS PLANT AREA BOUNDARY
- LIMITS OF CAPPING
- LIMITS OF BACKFILL AND CAPPING IN ON-SITE LAGOON
- LIMITS OF BACKFILL AND REVEGETATION OF TIDAL MARSH

Figure 13
SITE-WIDE SELECTED REMEDY
Halby Chemical Site

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A passive type of gas collection system using gas vents may be necessary in areas above the vicinity of the carbon disulfide treatment zone. The appropriateness of a gas collection system will be determined during the design process.

Performance Standards

Areas containing contaminated soil will be paved with asphalt or paved utilizing an aggregate with a suitable "environmentally friendly" binder such as the resin modified emulsion ROAD OYL®. A conceptual drawing of the cap profile is included in Figure 11; the actual cap profile (materials and thickness of respective layers) will be developed in the design. The actual size and locations of the capped areas will be determined during the Remedial Design phase of the project. All soils containing greater than 38 ppm arsenic will be capped. The cap will cover all known contaminated soil, including the carbon disulfide treatment zone.

An engineered surface water runoff and erosion control system will be designed in accordance with Delaware Storm Water Control Regulations and installed to control surface water runoff. The system will include surface grading and storm water retention basins and outfall structures, as necessary.

2. Excavation of Contaminated Soil from Residential Parcel

Contaminated surface soil which has eroded onto the adjacent residential property will be excavated and consolidated under the cap along with existing contaminated soil. Preliminary soil sampling indicates that excavation on the residential property may be limited to a depth of approximately three feet in the backyard. Sampling to delineate the soil exceeding the 14 ppm arsenic performance goal may either be performed prior to or during excavation activities. After removal of soil containing greater than 14 ppm arsenic, the residential property will be backfilled with clean fill material, six inches of topsoil and vegetated.

Performance Standards

Soil on the residential parcel which contains an arsenic concentration of greater than 14 ppm shall be excavated and consolidated onto the industrial parcel. The residential property will be backfilled with clean fill material and a minimum of six inches of topsoil and regraded to ensure proper drainage. The property will be revegetated to minimize erosion and in accordance with reasonable aesthetic requirements based on consultation with the residential property owner. In the event that the residential property owner chooses to take action to convert the parcel to industrial use, the requirement to cap soils containing greater than 38 ppm arsenic would apply.

LAGOON AND MARSH

3. Backfill and Cap Lagoon with Paved Surface

Clean fill will be used to backfill the lagoon to surrounding grade. Sediment in the I-495 drainage ditch will be excavated and consolidated with the lagoon (or marsh) sediment prior to cap construction. The I-495 drainage ditch will be backfilled with clean soil to its previous grade to continue to provide a conduit for road runoff water to the Christina River. The potential benefit of placing a layer of geotextile between the contaminated sediments and the clean backfill will be evaluated during the Remedial Design. The lagoon will be capped with a surface such as asphalt pavement suitable for use in an industrial area. The cap to be constructed over the backfilled lagoon will likely be consistent with the cap profile to be constructed over the contaminated soil. Storm water control measures will be integrated with the Site-wide requirements

For cost estimation purposes, it is assumed that a water treatment plant would be mobilized to the Site and operated to treat surface water extracted from the lagoon and marsh during construction activities. Standard sediment control measures will be evaluated for Site application during the Remedial Design. If engineering controls, such as a series of sedimentation basins, are determined sufficient to achieve adequate surface water quality during the lagoon and marsh construction activities the water treatment plant will not be required.

Performance Standards

The entire on-Site lagoon will be backfilled to the surrounding grade in a manner to promote drainage to storm water control basins. After backfilling, the former lagoon area will be paved with a cap designed to withstand loads consistent with the rest of the Site The actual cap profile (materials and thickness of respective layers) will be developed in the Remedial Design.

The uppermost 12 inches of sediment in the I-495 drainage ditch located between Terminal Avenue and the Christina River will be excavated and consolidated with the lagoon (or marsh) sediment prior to cap construction. The I-495 drainage ditch will then be backfilled to the original grade with clean material to establish a conduit for storm water to discharge to the Christina River.

4. Backfill and Cover Marsh with Topsoil

The marsh extending from its northern reach to its southeastern boundary, Christina Avenue, will be backfilled with clean fill in a manner similar to the lagoon. The former marsh area will be covered with topsoil and vegetated to minimize erosion.

Performance Standards

The entire tidal marsh up to its southeastern boundary with Christina Avenue (see Figure 9) will be backfilled to the surrounding grade in a manner to promote drainage to storm water control basins. The former marsh area will be covered with a minimum of 6 inches of topsoil and vegetated to minimize erosion.

An engineered surface water runoff and erosion control system will be designed in accordance with Delaware Storm Water Control Regulations and installed to control surface water runoff. The system will include surface grading and storm water retention basins and outfall structures, as necessary.

5. Create Wetlands at Off-Site Location

The elimination of the lagoon and marsh as wetlands (approximately 7 acres) will require compensation by creating healthy wetland habitat of equal or greater function and value. Creation or enhancement of wetlands to compensate for the loss due to implementation of this remedy will be accomplished off-Site. The specific location for the wetland replacement project will be determined in consultation with Federal, State and local authorities. The preference is to complete the project in a tidal wetland/shallow water complex in the Christina River. The delineation of wetlands/shallow water habitat to be impacted may be refined by survey during the Remedial Design. Assessment of value and function perfomed by the wetland to be eliminated may be refined by an appropriate model during the Remedial Design. An appropriate habitat mitigation ratio for acceptable compensation will be determined in consideration of the off-Site creation/enhancement project selected.

The Army Corps of Engineers Wetlands Delineation Manual (1997) identifies three distinguishing characteristics of a wetland. These characteristics are soils, hydrology, and vegetation and wildlife usage. A monitoring plan must be developed that will measure these distinguishing characteristics and determine the success of the mitigation activities.

Performance Standards

The specific size, type and location of the compensatory wetland enhancement/creation project will be developed in consultation with Federal and State Natural Resource Trustees and local authorities and shall be set forth in the Remedial Design. Elements of the wetland mitigation project work plan and/or design will include the following:

- Compensatory wetland project must incorporate specifications for soil substrate grain size distribution and organic content consistent with the natural wetlands within the watershed supporting the mitigation site.

- Compensatory wetland project must incorporate drawings and specifications which will establish hydrology consistent with the hydrology of natural wetlands within the watershed supporting the mitigation site.

- Compensatory wetland project must incorporate specifications necessary to establish a flora and fauna community consistent with the community occurring in natural wetlands within the watershed supporting the mitigation site. The project may include a combination of species planting and natural colonization, as appropriate.

- Compensatory wetland project must incorporate specifications and drawings necessary to minimize potentially destructive erosion within the mitigation project area.

- Compensatory wetland project must incorporate long-term monitoring criteria to demonstrate success of this wetland project.

GROUND WATER

6. Institutional Controls, Implement Ground Water Management Zone

Institutional controls will be placed in conformance with the ground water management zone established by DNREC encompassing the Halby Chemical Site. DNREC's ground water management zone eliminates the potential for future exposure to ground water by ensuring that no public or domestic water supply wells are permitted in any aquifer beneath the Halby Chemical and Potts Property State Superfund Sites. EPA will establish deed restrictions to further prevent the installation of wells on the parcels comprising the Site.

SITE WIDE

7. Long-Term Monitoring

Operation and maintenance will be performed to ensure the integrity of the cap and minmize erosion of the soil cover. Maintenance activities will include periodic resealing and repairing cracks in the cap and gas monitoring, as appropriate. Surface water control structures must be maintained. Specific plans for long-term maintenance of the cap and surface water control structures shall be included in a post-construction maintenance plan.

Long-term chemical monitoring will be performed to confirm that the containment components are preventing off-Site migration of Site-related contaminants. The monitoring program will include chemical monitoring of sediment and surface water in the I-495 drainage ditch, the Lobdell Canal and the Christina River. The specific monitoring program will be developed during the Remedial Design. The monitoring plan will establish chemical-specific trigger values leading to the incorporation of biological testing methods.

Periodic monitoring of ground water in the Columbia, Upper Potomac and Lower Potomac Aquifers will be conducted to track Site-related contamination over time. The specific ground water monitoring plan will be developed during the Remedial Design. The ground water monitoring well network will be comprised of a combination of existing and new monitoring wells established to optimize the monitoring program. The network will include additional monitoring wells located south of the Halby Chemical Site and screened in the Lower Potomac Aquifer.

Off-Site activities will include appropriate monitoring and maintenance of the created/enhanced compensatory wetland area. The monitoring plan must incorporate provisions necessary to periodically measure or characterize hydrology, erosion, and vegetation and wildlife usage. The plan must establish triggers that initiate additional maintenance work if erosion becomes a destructive problem or invasive vegetation such as *Phragmites sp.* choke out indigenous species from the compensatory wetland area. In Delaware a number of invasive species have been identified by the state.

Performance Standards

All monitoring wells must be installed, maintained and abandoned in accordance with the substantive provisions of Delaware Regulations Governing Construction of Water Wells, as amended (April 6, 1997).

8. Institutional Controls

In addition to the deed restriction identified in Section IX.B.6, above, restrictions shall be placed on the parcels comprising the Site to ensure that the remedy components are not compromised. Any site activities involving subsurface work must be completed by properly trained workers in a manner that is protective of human health and the environment. All parties holding easements to the property (i.e., subsurface utilities) must be notified of the presence of soil contaminated with hazardous substances.

Five-Year Reviews

Long-term monitoring, and operation and maintenance of the cap shall continue for an estimated 30 years or such other time period as EPA, in consultation with DNREC, determines to be necessary, based on the statutory reviews of the remedial action which shall be conducted no less often than every five years from the initiation of the Remedial Action in accordance with the EPA guidance document, *Structure and Components of Five-Year Reviews* (OSWER Directive 9355.7-02, May 23, 1991). Five-year statutory reviews under Section 121(c) of CERCLA, 42 U.S.C. § 9621(c) will be required, as long as hazardous substances remain on-Site and prevent unlimited use of the Site. Five-year reviews shall be conducted after the remedy is implemented

to assure that the remedy continues to protect human health and the environment. A Five-year Review Work Plan shall be required and shall be approved by EPA in consultation with the DNREC.

X. STATUTORY DETERMINATIONS

EPA's primary responsibility at Superfund sites is to select remedial actions that are protective of human health and the environment. Section 121 of CERCLA, 42 U.S.C. § 9621 also requires that the selected remedial action comply with ARARs, be cost effective, and utilize permanent treatment technologies to the maximum extent practicable. The following sections discuss how the Selected Remedy for the Halby Chemical Site meets these statutory requirements.

A. Protection of Human Health and the Environment

Based on the Human Health Baseline Risk Assessment for the Halby Chemical Site, action should be taken to reduce potential risk from arsenic in the soil and sediment at the Site. In addition, measures should be considered to prevent exposure to ground water beneath the Site. Arsenic was selected as a contaminant of concern with respect to the soil and sediment because potential health hazards for some exposure scenarios exceeded either the EPA target range of 1.0×10^{-6} (or 1 in 1,000,000) to1.0×10^{-4} (or 1 in 10,000) for increased lifetime cancer risk or a non-cancer Hazard Index of 1.0. The results of the Ecological Risk Assessment show that Site soil, the lagoon and marsh sediment, and surface water present an unacceptable risk to ecological receptors.

The capping of contaminated soil and sediment called for in the Selected Remedy will prevent exposure to unsafe levels of contaminants; provide a stable, maintainable surface; and minimize erosion. These measures will both reduce the human health risks presented by the Site to within EPA's target range and prevent exposure of ecological receptors to unhealthy levels of Site soil and sediment and surface water contamination in the on-Site lagoon and adjacent tidal marsh. The creation or enhancement of existing wetland habitat of equal function and value at an off-Site location to compensate for the wetlands to be lost during implementation of the remedy will ensure the presence of wetland habitat essential to the ecosystem.

The institutional controls called for in the Selected Remedy will augment the institutional controls being implemented by DNREC and continue to prevent human exposure to on-Site ground water contaminants. The institutional controls create a circumstance which is protective of human health.

Implementation of the Selected Remedy will not pose any unacceptable short term risks or cross media impacts to the Site, or the community.

B. Compliance with and Attainment of Applicable or Relevant and Appropriate Requirements ("ARARs")

The Selected Remedy will comply with all applicable or relevant and appropriate chemical-specific, location-specific and action-specific ARARs. Those ARARs are identified in Table 4.

C. Cost-Effectiveness

The Selected Remedy is cost-effective in providing overall protection in proportion to cost, and meets all other requirements of CERCLA. Section 300.430(f) (ii) (D) of the NCP requires EPA to evaluate cost-effectiveness by comparing all the alternatives which meet the threshold criteria - protection of human health and the environment and compliance with ARARs - against three additional balancing criteria: long-term effectiveness and permanence; reduction of toxicity, mobility or volume through treatment; and short-term effectiveness. The Selected Remedy meets these criteria and provides for overall effectiveness in proportion to its cost. The combined estimated present worth cost for the Selected Remedy presented in this Record of Decision is $9,740,000.

D. Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The principal threat presented by carbon disulfide contamination at the Site was addressed in an expedited emergency removal response action. The carbon disulfide removal was accomplished by implementing an innovative *in situ* chemical oxidation technology. The reduction of carbon disulfide was both permanent and utilized an alternative treatment technology. The Selected Remedy addresses lower level threats remaining at the Site with waste containment, institutional controls and long-term monitoring and maintenance to provide the necessary level of protection of human health and the environment.

The EPA has determined that the Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost effective manner for the Site. Of those remedial alternative combinations that are protective of human health and the environment and comply with ARARs, the EPA has determined that the Selected Remedy provides the best balance in terms of short-term effectiveness; long-term effectiveness; implementability; cost; reduction in toxicity, mobility, and volume; State and community acceptance.

The Selected Remedy will reduce the risks soil and sediment pose to human health to within EPA's target risk range. EPA has determined that the use of more costly treatment technologies at the Site are not justifiable. Because all of the alternatives, with the exception of the No Action alternatives, offer a comparable level of protection of human health and the environment, the EPA has selected the Alternatives S-2, LM-4, G-2, and D-2 in combination, which can be

TABLE 4
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARS)
AND TO BE CONSIDERED MATERIAL (TBCs)FOR THE SELECTED REMEDY
HALBY CHEMICAL SITE

ARAR or TBC	Legal Citation	Classification	Summary of Requirement	Further Detail Regarding ARARs in the Context of the Selected Remedy
I. CHEMICAL SPECIFIC				
A. Water				
1. Delaware Surface Water Quality Standards	Delaware Surface Water Quality Standards, as revised February 26, 1993 Sections 4,5.6 and 9 Regulations promulgated pursuant to Section 6010 of 7 Delaware Code Chapter 60	Applicable	Criteria are provided to maintain surface water of satisfactory quality consistent with public health and recreational purposes, the propagation and protection of fish and aquatic life, and other beneficial uses of water.	Any surface water discharge must not contribute to or cause an excursion to these "in stream" water quality criteria.
2. Clean Water Act: Federal Ambient Water Quality Criteria for the Protection of Aquatic Life	33 U.S.C. § 1314 40 C.F.R. § 131.36	Relevant and Appropriate	These are non-enforceable guidelines established pursuant to Section 304 of the Clean Water Act that set the concentrations of pollutants which are considered adequate to protect human health based on water and fish ingestion and to protect aquatic life. Federal ambient water quality criteria may be relevant and appropriate to CERCLA cleanups based on the uses of a water body.	The section of the Christina River nearest the Site is designated for secondary recreational use and protection of aquatic life. These criteria are relevant and appropriate to the River unless a State water quality standard exists for that particular pollutant.
B. Soil				
1. Risk Assessment Guidance for Superfund - Volume 1 Human Health Manual Part A	Risk Assessment Guidance for Superfund Volume 1 - Human Health Manual Part A, December 1989 (EPA Office of Emergency and Remedial Response EPA/540/1-89/002)	To be Considered	EPA guidance for calculating baseline human health risk and establishing risk-based performance standardsfor Superfund clean-ups. Section 7.4 sets forth method for identifying appropriate toxicity values for contaminants of concern.	There are currently no ARARs establishing acceptable concentrations for contaminants in soil or sediment at the Site.This guidance document was considered when establishing risk based performance goals set forth in the Selected Remedy.

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II. LOCATION SPECIFIC				
A. Wetlands and Floodplains				
1. Federal Regulation of Activities in or Affecting Wetlands	40 C.F.R. 6.302(a) and Part 6 Appendix A	To Be Considered	Sets forth general requriements for carrying out provisions of Executive Order 11990 (Protection of Wetlands). Adverse impacts associated with the destruction or loss of wetlands must be avoided to the extent possible. If there is no other more practicable alternative, impacts must be minimized and/or mitigated.	The Selected Remedy includes filling in chemically degraded wetlands. EPA, in consultation with the Department of the Interior, the Department of Commerce and DNREC, has determined that there is no more practicable alternative that has less effect. The loss of on-Site wetlands will be mitigated through the creation/enhancement of compensatory wetlands.
2. State Executive Order on Freshwater Wetlands (1988), including Governor's Roundtable Report (1989)	State Executive Order 56 on Freshwater Wetlands (1988)	To Be Considered	General policy to minimize the adverse effects to wetlands.	Selected Remedy includes creation/enhancement of wetlands to compensate for the degraded on-Site wetlands to be backfilled.
3. Coastal Zone Management Act of 1972; Reauthorization Amendments of 1990	16 USC 1451 *et seq.* 15 C.F.R. §§ 930.17, 20, 31-33, 37(a), 39(b-d)	Applicable	Requires that Federal agencies conducting or supporting activities directly affecting the coastal zone, conduct or support those activities in a manner that is consistent with the approved appropriate State coastal zone management program. (See Delaware's Comprehensive Update and Routine Program Implementation, March 1993)	The Halby Chemical site is within the coastal zone. The project will be conducted in a manner that is consistent with the approved Delaware coastal zone management program, to the maximum extent practicable.
4. Federal Regulation of Activities in or Affecting Floodplains	40 C.F.R. 6.302(b) and Part 6 Appendix A	To Be Considered	Sets forth general requriements for carrying out provisions of Executive Order 11988 (Floodplain Management). Adverse impacts on floodplains must be avoided to the extent possible. If there is no other more practicable alternative, impacts must be minimized and/or mitigated.	The Selected Remedy includes filling activities within the 100-year floodplain. Actions to restore the floodplain so that its natural and beneficial values can be realized will be considered and incorporated into the Remedial Design, as appropriate.

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5. Fish & Wildlife Coordination Act	16 USC 661 *et seq.* 40 C.F.R. 6.302(g)	To Be Considered	Requires Federal agencies that are involved in actions that will result in the control or structural modification of any natural stream or body of water for any purpose to take action to protect the fish and wildlife resources which may be affected by the action. Consultation with the U.S. Fish and Wildlife Service and the appropriate State agency is required to ascertain the means and measures necessary to mitigate, prevent, and compensate for project-related losses of wildlife resources and to enhance the resources.	The US Fish and Wildlife Service and the Delaware DNREC have been, and will continue to be, consulted during assessment and planning activities. Compensatory wetlands will be created/enhanced to replace those lost during implementation of the Selected Remedy.
6. Clean Water Act: Fill Material Discharged to Waters of the U.S.	33 U.S.C. § 1344 40 C.F.R. §§ 230.10(d), .72(a)(2)(b), .75(d)	Applicable	When it has been determined that there is no practicable alternative to capping wetland, Section 404(b)(1) of the Clean Water Act provides general guidelines for appropriate and practicable mitigation measures to compensate for adverse impact.	EPA has determined that there is no practicable alternative to backfilling the chemically degraded wetlands. § 230.10(d) requires practicable steps be taken to minimize adverse impacts on the ecosystem. § 230.72(a)(2)(b)recommends capping in-place contaminated material with clean material. § 230.75(d) states that habitat development and restoration techniques can be used to minimize adverse impacts to compensate for destroyed habitat.
III. ACTION SPECIFIC				
A. Water				
1. Clean Water Act (CWA); National Pollutant Discharge Elimination System Requirements	33 U.S.C. § 1251; 40 C.F.R. §§ 122.41-122.50	Applicable	Enforceable standards for all discharges to waters of the United States.	Storm water controls will be implemented to prevent run off from contacting contaminated soil. In the event that water displaced from the lagoon is treated for on-Site discharge, substantive requirements of the NPDES program will apply. In accordance with CERCLA Secion 121(e) no permit shall be required for actions conducted entirely on-Site.
2. Delaware Regulations Governing Construction and Use of Wells	Delaware Regulations Governing Construction and Use of Wells (April 6, 1997) Sections 3,4,5,6,7,8,9,10	Applicable	Requirements governing the location, design, installation, use, disinfection, modification, repair, and abandonment of all wells and associated pumping equipment.	All wells will be installed, maintained and abandoned in accordance with the substantive portions of these state regulations.

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3. Delaware Regulations Governing the Control of Water Pollution, as amended June 23, 1983	Delaware Regulations Governing the Control of Water Pollution §§ 3.01 and 8.0 Regulations promulgated pursuant to Sectioni 6010 of 7 Delaware Code, Chapter 60	Applicable	Contains water quality regulations for discharge into surface water.	Storm water controls will be implemented to prevent runnoff from contacting contaminated soil. In the event that water displaced from the lagoon is treated for on-Site discharge, technology based limits will apply. In accordance with CERCLA Secion 121(e) no permit shall be required for actions conducted entirely on-Site but substantive requirements will be met.
B. Air				
1. Delaware Regulations Governing the Control of Air Pollution	Delaware Regulations Governing the Control of Air Pollution Regulations 2 and 6	Applicable	Sets forth the requirement that a permit is necessary if emissions will exceed 10 lbs/day. Although a permit is not necessary for onsite activities, all substantive requirements must be met. Regulation 2 describes general conditions, Regulation 6 deals with particulate emissions from construction and materials handling	Excavation and grading associated with consolidation and capping components of the Selected Remedy must employ methods, such as application of water, to minimize particulate air emission.
C. Waste Handling and Disposal				
1. Delaware Regulations Governing Hazardous Waste	Delaware Regulations Governing Hazardous Waste: Regulations promulgated pursuant to 7 Delaware Code Chapter 63 See below for specific State citations	See below	Delaware Regulations Governing Hazardous Waste, Part 261 define "hazardous waste". The regulations listed below apply to the handling of such hazardous waste.	See below
2. Resource Conservation and Recovery Act of 1976 (RCRA); Hazardous and Solid Waste Amendments of 1984	See below for specific federal citations.	See below	Regulates the management of hazardous waste, to ensure the safe disposal of wastes, and to provide for resource recovery by controlling hazardous wastes "from cradle to grave."	Federal regulations would not apply for those RCRA regulations which Delaware has the authority from EPA to administer. See below
a. Identification and Listing of Hazardous Wastes	Delaware Regulations Governing Hazardous Wastes, §§ 261.20-.24	Applicable	Identifies solid wastes which are identified as hazardous wastes.	Criteria to be used in determining whether wastes are subject to RCRA hazardous waste regulations.
b. Identification and Listing of Hazardous Wastes	EPA Regulations, 40 C.F.R. §§ 261.20-.24	Relevant and Appropriate	Identifies solid wastes which are identified as hazardous wastes.	Criteria to be used in determining whether wastes are subject to RCRA hazardous waste regulations.

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c. RCRA Requirements for Use and Management of Containers	Delaware Regulations Governing Hazardous Waste, §§ 264.171-178	Applicable	Requirements for storage of hazardous waste in storage containers.	In the event that stored materials are identified as hazardous waste, applicable for temporary storage containers.
d. RCRA Requirements for Use and Management of Containers	EPA Regulations, 40 C.F.R. § 264.175	Relevant and Appropriate	Requirements for storage of hazardous waste in storage containers.	In the event that stored materials are identified as hazardous waste, applicable for temporary storage containers.
e. RCRA Requirements for Waste Piles	Delaware Regulations Governing Hazardous Waste, §§ 264.250-.258(a)	Applicable	Requirements for design, operation and closure of waste piles	In the event that stockpiled materials are identified as hazardous waste, applicable for waste piles.
f. RCRA Requirements for Waste Piles	EPA Regulations, 40 C.F.R. §§ 264.251-.256, .259	Relevant and Appropriate	Requirements for design, operation and closure of waste piles	In the event that stockpiled materials are identified as hazardous waste, applicable for waste piles.
g. Standards Applicable to Generators of Hazardous Waste	Delaware Regulations Governing Hazardous Waste, §§ 262.10-.33, .40, .42, .50	Applicable	Establishes standards for generators of hazardous wastes including waste determination manifests and pre-transport	If water treatment plant is necessary, applicable to operator of the wastewater treatment plant if the residues are hazardous.
h. Standards Applicable to Generators of Hazardous Waste	EPA Regulations, 40 C.F.R. §§ 262.10, 262.20(a)-(d), 262.21, .23, .50-.55, .57	Relevant and Appropriate	Establishes standards for generators of hazardous wastes including waste determination manifests and pre-transport	If water treatment plant is necessary, applicable to operator of the wastewater treatment plant if the residues are hazardous.
D. Soils/Sediments				
1. Delaware Sediment and Stormwater Regulations	Delaware Sediment and Stormwater Regulations, January 23, 1991, as amended March 11, 1993 Sections 3, 6, 10, 11, 15 Regulations promulgated pursuant to 7 Delaware Code Chapter 40	Applicable	Establishes management programs for construction projects that disturb more than 5,000 sf of land.	Applicable for erosion and storm water control during excavation,grading and paving activities associated with the Selected Remedy. Storm water control measures must be designed and implemented so that post-construction run-off rates do not exceed pre-construction run-off rates.
E. Miscellaneous				
1. Delaware Coastal Zone Act; Coastal Zone Act Regulations, June 9, 1993	Delaware Coastal Zone Act 7 Delaware Code Chapter 70 Sections 7003, 7004	To be considered	Establishes management policies related to a wide range of coastal, beach, wetlands, woodlands and other natural areas.	Will require incorporation of management plans for adequate wetland areas and flood hazard areas.

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2. Delaware Regulations Governing Hazardous Substance Cleanup Act	Delaware Regulations Governing Hazardous Substance Cleanup, September 1996: Section 8.10 and 9.4 Regulations promulgated pursuant to 7 Delaware Code Chapter 91	Relevant and Appropriate	State regulations for investigation and cleanup of hazardous waste sites listed on the State Superfund List. Sections considered relevant and appropriate are provisions addressing institutional controls and soil cleanup standards (1×10^{-5}; Hazard Index of 1; or natural background if higher)	Relevant and appropriate for the development of soil cleanup standards. Cleanup standards and provisions for deed restrictions included in the Selected Remedy are consistent with State law.
3. Worker Safety	29 C.F.R. § 1910.120	Applicable	Establishes proper training and personal protection requirements for workers who may be potentially exposed to hazardous substances while performing job functions.	Workers will be properly trained and will wear appropriate Personal Protection Equipment for activities to be conducted at the Halby Chemical Site.

implemented quickly; will have little of no adverse effects on the surrounding community; and will cost considerably less than the other alternatives.

E. Preference for Treatment as a Principal Element

EPA expedited the appropriate cleanup activities at the Site by addressing the potential immediate threats to human health and the environment through removal response actions. The removal activities, which included decontamination and dismantlement of the former chemical production facility and subsurface carbon disulfide removal was accomplished by implementing an innovative *in situ* chemical oxidation treatment technology. In addition, much of the chemical residues collected during the chemical plant dismantlement were sent off-Site for proper treatment at EPA-approved hazardous waste treatment facilities. The Selected Remedy addresses lower level threats remaining at the Site with waste containment, institutional controls and long-term monitoring and maintenance. To the extent that removal response actions orchestrated as part of the Site-wide cleanup are considered, the Selected Remedy satisfies the statutory preference for treatment as a principal element.

XI. DOCUMENTATION OF CHANGES FROM PROPOSED PLAN

The following minor changes have been made since the Proposed Plan was issued on July 31, 1997:

The size of the wetland habitat to be impacted has been modified from approximately 8 ½ acres to approximately 7 acres. This revision is the result of a more accurate measurement of existing wetlands and does not reflect a material change to the proposed remedy.

EPA received comments during the public comment period expressing concern regarding the potential contaminant migration to the Christina River. EPA carefully considered the comments and has augmented the long-term ground water monitoring plan with provisions for chemical monitoring of sediment and surface water in the I-495 drainage ditch, the Lobdell Canal and the Christina River. The specific monitoring program will be developed during the Remedial Design and included in the operation and maintenance plan for the Site.

Executive Order 11990 (Protection of Wetlands), set forth at 40 C.F.R. Part 6, Appendix A, was identified as a location specific ARAR in the Proposed Plan. Executive Order 11990 contains important information regarding activities taken in or around wetlands, however it is not legally enforceable so is not an ARAR. Executive Order 11990 has been identified as "to-be-considered"material in this ROD.

STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES
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DIVISION OF AIR & WASTE MANAGEMENT
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March 30, 1998

Abraham Ferdas, Acting Director, 3HW00
Hazardous Waste Management Branch
Environmental Protection Agency, Region III
841 Chestnut Building
Philadelphia, Pennsylvania 19107

Re: States' Concurrence with Record of Decision dated March 1998
Halby Chemical Federal Superfund Site
Wilmington and New Castle, New Castle County, Delaware

Dear Mr. Ferdas:

This letter is to officially express the State of Delaware, Department of Natural Resource and Environmental Control's ("Department") concurrence with the Record of Decision dated March 1998 for the Halby Chemical Federal Superfund Site located at 600 Terminal Avenue in Wilmington and New Castle in New Castle County, Delaware.

The Department has been actively participating in the investigation and the assessment of risks at the site. In addition, the Department has actively participated in the Emergency Removal Action conducted by EPA starting in February 1995 as well as the work being performed by Witco under the Unilateral Order of August 1995. Further, the Department has been actively involved in the selection of the remedy at the site.

Immediately to the north of the Halby Site is the Potts Property Site ("Potts") which is presently being addressed under the state's Hazardous Substance Cleanup Act authority. Groundwater that leaves Halby goes under Potts and eventually makes its way to the Christina River. If, during the course of the HSCA investigation it is determined that groundwater from Halby is impacting the Christina River's ambient water quality, then the Halby responsible parties will be called upon to participate in the HSCA groundwater remedy at Potts.

We look forward to the implementation of the remedy, which we believe will provide a protective (both to human health and the environment). as well as a cost-effective remedy for the site.

Sincerely yours,

William G. Hill
-for
Nicholas A. Di Pasquale
Director

NADP/JFBS/jfbs
JFB98034.DOC
DE0067 11 105

cc: Christophe A. G. Tulou, Secretary DNREC
N.V. Raman, Branch Manager SIRB-DNREC
Jamie H. Rutherford, Program Manager SIRB-DNREC
Jane Biggs Sanger, Project Manager SIRB-DNREC
Eric Newman, EPA Remedial Project Manager
Peter Ludzia, EPA Program Manager
Project File

RESPONSIVENESS SUMMARY
FOR THE PROPOSED REMEDIAL ACTION PLAN
FOR THE HALBY CHEMICAL SUPERFUND SITE
OPERABLE UNIT TWO

WILMINGTON, NEW CASTLE COUNTY, DELAWARE

Public Comment Period
July 30, 1997 to September 29, 1997

Halby Chemical Superfund Site
Responsiveness Summary for the Proposed Remedial Action Plan
Operable Unit Two

TABLE OF CONTENTS

	page
Overview	2
Background	4
Part I: Summary of Commentors' Major Issues and Concerns	7

A.	Site Conditions	8
B.	Contaminants and Health Risks	12
C.	Potential Past Exposure and Historical Issues	14
D.	Implementation and Effectiveness of Remediation Plan	16
E.	Superfund Program and Process	20
F.	Enforcement	22
G.	Communication of Site-Related Information	24

Part II: Responses to Written Comments 28

A.	Comments from Witco Corporation	28
B.	Comments from Sierra Club, Delaware Chapter	35
C.	Comments from City of Wilmington, Delaware	38
D.	Comments from F&H Transport	39

This Responsiveness Summary is divided into the following sections:

Overview: This section discusses the U.S. Environmental Protection Agency's ("EPA") Selected Remedy for reducing elevated risks presented by the Halby Chemical Site.

Background: This section provides a brief history of community relations activities conducted during remedial planning at the Halby Chemical Superfund Site.

Part I: This section provides a summary of commentors' major issues and concerns and expressly acknowledges and responds to those comments provided by the community during the 60-day public comment period, including the August 18, 1997 public meeting. Commentors included area residents, concerned citizens groups, local businesses, the municipalities, and potentially responsible parties ("PRPs").

Part II: This section provides a response to written comments received from the community during the public comment period.

Overview

On July 30, 1997 EPA announced the opening of the public comment period and released the Proposed Remedial Action Plan ("Proposed Plan") for Operable Unit Two of the Halby Chemical Superfund Site ("Site"), located in Wilmington, New Castle County, Delaware. The Proposed Plan detailed EPA's preferred alternatives to clean up the Site contamination, giving consideration to the following nine evaluation criteria:

Threshold Criteria

- Overall protection of human health and the environment
- Compliance with Federal, state, and local environmental and health laws

Balancing Criteria

- Long-term effectiveness and permanence
- Reduction of mobility, toxicity, or volume of contaminants through treatment
- Short-term effectiveness
- Implementability
- Cost

Modifying Criteria

- State acceptance
- Community acceptance

EPA carefully considered state and community acceptance of the clean-up alternatives before reaching the final decision regarding the remediation plan. This Record of Decision ("ROD") details EPA's final clean-up decision.

EPA's Selected Remedy is a combination of the best clean-up alternatives for each medium evaluated at the Site and is summarized below. Based on current information, the remedy selected provides the best balance among the alternatives with respect to the nine evaluation criteria EPA used to evaluate each alternative. EPA's Selected Remedy addresses contaminated soil, sediment in the area waterways, and the potential for future exposure to contaminated groundwater.

Soil

Alternative S-2: Paved Surface Cap, Surface Water Runoff Controls, Long-term Monitoring, and Institutional Controls

- Cover the areas of the Site where soil exceeds 38 mg/kg arsenic with a paved cap.
- Excavate soil on the adjacent residential property that exceeds 14 mg/kg arsenic and combine with the contaminated soil under the cap.
- Backfill the residential property with clean soil, cover with six inches of topsoil and re-establish vegetation.
- Monitor gas in the area of the carbon disulfide treatment zone; install a gas collection system, if necessary.
- Install a system to control both surface water and soil erosion.
- Conduct long-term monitoring to ensure the integrity of the cap.
- Implement deed restrictions on the property.

Lagoon and Marsh

Alternative LM-4: Backfill Contaminated Wetlands, Pave Lagoon Surface, Wetlands Compensation, and Institutional Controls

- Drain the lagoon and marsh, excavate the I-495 drainage ditch sediments, and place the sediments in the lagoon/marsh area.
- Backfill and level the lagoon and marsh with clean soil.
- Cap the lagoon area with a paved surface; cover the marsh area with topsoil and establish vegetation.
- Utilize a mobile water treatment plant to treat water taken from the lagoon and marsh, if necessary.
- Create a new wetlands area at an off-Site location, equivalent in function and value to the approximately 7 acres of the on-Site lagoon and marsh areas to be eliminated.
- Conduct long-term maintenance to ensure the integrity of the cap and the created wetland.
- Implement deed restrictions on the the property.

Ground Water, Including the Dense Non-Aqueous Phase Liquids
Alternatives G-2 and D-2: Institutional Controls and Continued Monitoring

- Implement institutional controls in conformance with the ground water management zone established by DNREC encompassing the Site. EPA will establish deed restrictions to further prevent the installation of drinking water wells on the parcels comprising the Site.
- Conduct monitoring to track Site-related contamination.

Background

Recently, some residents have become concerned about the potential health implications of environmental degradation within the south Wilmington area, in general, and interest in the Halby Site has increased. Residents are aware of the Site clean-up and are becoming more involved with the Site.

Until the past year, interviews and community interactions have revealed a moderate level of community interest among area business owners, residents, and state and local officials. The moderate interest level was attributed to the isolation of the Site from residential areas, the Site's location among other industrial facilities in the area and the fact that the Site currently supports several small industrial businesses. There have not been any chemical production activities at the Site since 1980.

Despite only moderate community interest after the chemical production ceased, residents filed several Site-related complaints during the years that the chemical plant was in operation (1948-1980) concerning the lagoon overflow, hydrogen sulfide-like odors, and numerous spills at the Site. Some of the complaints included:

- A spill of 100-500 gallons of ammonium sulfide;
- A spill of 2,400 gallons of anhydrous ammonia;
- Complaints of hydrogen sulfide inhalation;
- A spill of 50 gallons of unstripped ammonium thiocyanate; and
- A pipe leak of sodium hydrosulfite.

In March 1984, EPA performed a Site Inspection ("SI"). Samples collected during the inspection revealed high levels of organic and inorganic compounds at the Site. The results of the SI signaled the beginning of Superfund activities at the Site.

In 1985, EPA reviewed the Site using the Hazard Ranking System ("HRS"). The HRS is EPA's tool for evaluating risks to public health and the environment associated with hazardous waste sites. EPA proposed that the Site be included on the National Priorities List ("NPL") in September 1985. EPA finalized listing of the Site on the NPL in June 1986, making Superfund money available.

EPA performed the Remedial Investigation ("RI") for the soil around the process plant area in September 1990. During the RI, EPA sampled the soil, surface water, ground water, and

sediments. EPA installed ground water monitoring wells to determine the amount and types of contamination at or near the Site and to study the geology and hydrogeology of the area.

In March 1991, EPA conducted community interviews to identify community interest and concern. EPA also established two information repositories: Wilmington Public Library, 10th & Market Streets, Wilmington, Delaware 19801, (302) 571-7416 and EPA Region III, 841 Chestnut Street, Philadelphia, Pennsylvania 19107, (215) 566-3157.

On April 19, 1991 EPA released the first operable unit Remedial Investigation/Feasibility Study Report and the Proposed Plan for the first operable unit ("OU-1") focusing on soil within the former process plant area of the Site. EPA divides sites into operable units ("OUs") or components to make site clean-ups more manageable. EPA held a public comment period from April 19, 1991 through June 3, 1991 to solicit public response to the Proposed Plan. EPA also held a public meeting on May 2, 1991 to answer the public's questions and concerns about the Site. A summary of the questions and EPA's responses is available in the Responsiveness Summary of the ROD for OU-1 issued on June 28, 1991 by EPA.

In early 1992, EPA and Witco Corporation ("Witco"), a potentially responsible party ("PRP"), signed a legal document wherein Witco agreed to perform the soil clean-up response actions required at the process plant area.

In 1993, EPA began a second Remedial Investigation to augment its understanding of the nature and extent of contamination for each medium (soil outside the former chemical production facility, surface water, ground water, and sediments in the area waterways) at the Site. Upon completion of the second RI and Risk Assessment, EPA developed and evaluated potential response actions to reduce the risks presented by the Site-related contamination. This information is contained in the second Feasibility Study.

On February 3, 1995, EPA completed a Removal Site Assessment focusing on the portions of the former chemical production facility and tank farm which were not being utilized by Brandywine Chemical Company and were not properly decontaminated or maintained. On February 22, 1995 EPA issued an Action Memorandum documenting removal assessment findings and immediate actions planned to address the presence of various hazardous substances located in numerous tanks, process lines, reaction vessels, sumps and drains, drums, pressurized cylinders and other containers. EPA notified DNREC and the Wilmington and New Castle County Local Emergency Planning Committees of Site conditions and coordinated planning activities.

Between February and July 1995 EPA completed the removal activities identified in the Action Memorandum to mitigate the immediate threat posed by improperly stored chemicals in the former process plant area. Buildings and above-ground storage tanks within the former chemical process plant area were dismantled and disposed of off-Site, leaving a warehouse within the fence. EPA addressed the contents of an estimated 600 small containers and 13 pressurized cylinders found in the abandoned laboratory area; an estimated 200 drums and 50 tanks found in the warehouse area, chemical processing area, and tank farm; and approximately 1,000 small containers mixed with shallow soil near a concrete sump in the northwest corner of the former

process plant area. Chemicals in these containers and vessels were transported off-Site for appropriate treatment and/or disposal.

During completion of removal activities planned in the February 22, 1995 Action Memorandum, EPA identified an area of high carbon disulfide contamination extending from the point that waste water had been discharged from the chemical production facility to the lagoon. On July 6, 1995, a second Action Memorandum was issued documenting EPA's decision to address this area on an expedited basis.

On July 20, 1995, EPA issued a Unilateral Administrative Order for Removal Action EPA Docket No. III-95-55-DC ("Removal Order") to Witco. Pursuant to the Removal Order, Witco installed a security fence; constructed a berm to prevent the migration of contaminants from the on-Site lagoon; delineated the extent of carbon disulfide contamination; and completed laboratory treatability studies designed to identify the optimum process to destroy the carbon disulfide. Pilot-scale treatability studies were performed at the Site in December 1996 and April 1997. Full scale carbon disulfide treatment began in August 1997 and was completed in January 1998.

In December 1996, April 1997 and August 1997, EPA distributed fact sheets to all addressees located in the vicinity of the Site. The fact sheets explained the clean-up activities, provided status updates on soil treatment and testing at the Site, and notified citizens of contacts for additional information.

On August 18, 1997 following the release of the Proposed Plan for OU-2, EPA met with city officials and community representatives to discuss the Halby Site. Following that meeting, EPA held a public meeting at the DeLaWarr State Service Center in New Castle, Delaware to address the community's questions and concerns about the Proposed Plan. A fact sheet was available at the public meeting that explained the purpose of the public meeting and the Proposed Plan.

On September 23, 1997, EPA and the Delaware Department of Natural Resources and Environmental Control ("DNREC") participated in a Superfund workshop jointly sponsored by the Wilmington and New Castle County Local Emergency Planning Committees ("LEPC") to discuss the Halby Chemical Site, the Technical Assistance Grant ("TAG") program and the Superfund process, in general. The workshop was advertised as an open forum and the community was encouraged to attend.

The local community is becoming more involved and interested in the cleanup at the Halby Chemical Site. Community involvement in clean-up is an important component of the Superfund Program. EPA makes every effort to include interested citizens in the Superfund process. Following is EPA's response to questions and issues raised by the community during the public comment period on the Proposed Plan for OU-2.

Part I: Summary of Commentors' Major Issues and Concerns

This section provides a summary of commentors' major issues and concerns and EPA's response to them. Commentors include area business owners and employees, area residents, interested citizen groups, the municipalities, and PRPs. The major issues and concerns raised during the public comment period, are grouped into the following categories:

A.	Site Conditions
B.	Contaminants and Health Risks
C.	Potential Past Exposure and Historical Issues
D.	Implementation and Effectiveness of Remediation Plan
E.	Superfund Program and Process
F.	Enforcement
G.	Communication of Site-Related Information

A. Site Conditions

1. A citizen asked how much soil has been removed from the Site.

EPA Response: No soil has been removed from the Site. The Selected Remedy does not include soil excavation and off-Site disposal.

2. A citizen asked if the area is on an aquifer.

EPA Response: There are three water-bearing formations, or aquifers, beneath the Site. The water table is encountered between 5 and 15 feet below the ground surface. The Columbia formation and recent fill comprise the surficial aquifer which is approximately 20 to 30 feet thick across the Site. Below the Columbia Aquifer is an upper sand of the Potomac Aquifer which extends 60-75 feet below ground surface. Between these two aquifers, there is a 5-25 feet thick silt layer which reduces vertical water flow between them; however, this silt layer is absent beyond the Site toward the Christina River. The ground water in both the Columbia and Upper Potomac flows to the northeast, under the adjacent Potts Property State Superfund Site and toward the Christina River. The deepest unconsolidated aquifer at this Site is a lower sand of the Potomac Aquifer approximately 80-100 feet below ground surface. At the Site, the lower sand aquifer is confined with a 20-30 feet clay layer between it and the upper sand of the Potomac Aquifer. Ground water in the lower sand aquifer flows to the south. The United States Geological Survey determined that if any contamination reached the lower Potomac, it would take at least 120 years to reach the nearest well in the Collins Park well field that is 9,200 feet from the Halby Chemical site. The Selected Remedy requires long-term monitoring of ground water in each of the aquifers.

3. A citizen asked if any businesses or residents along Terminal Avenue have private drinking water wells.

EPA Response: All the businesses and homes along Terminal Avenue are connected to public drinking water supply. There are no drinking water wells withdrawing ground water from either the Columbia or Upper Potomac Aquifers within 2 miles downgradient of the Site. Delaware DNREC has formally established a ground water management zone encompassing the Halby Chemical Site, the Potts Property State Superfund Site and the Port of Wilmington and environs. The ground water management zone eliminates the potential for future exposure to ground water by ensuring that no public or domestic water supply wells are permitted in any aquifer beneath the Halby Chemical and Potts Property Superfund Sites.

4. A few citizens asked how EPA determined that future land use of the property would remain industrial.

EPA Response: EPA has determined that industrial use is a reasonable future land use assumption for the Halby Chemical Superfund Site for several reasons. The property referred to as the Halby Chemical Site is zoned as M-1, M-2, and M-3 which limits the land use to activities consistent with a Light Manufacturing Zone, General Industrial Zone, and Heavy Industrial Zone, respectively. F&H Transport and Brandywine Chemical Company each own one of the two parcels which comprise the Halby Chemical Site. Although chemical production activities no longer take place on the property, several small industrial businesses, including Christiana Motor Freight, F&H truck stop and refueling station and the Total Tire repair shop are located on the Site. The property owners plan to continue to utilize the parcels for industrial purposes consistent with the M-1, M-2 and M-3 zoning limitations. The surrounding parcels include the Forbes Steel plant to the north (across from Interstate 495), a hot-mix asphalt plant to the south and the Potts Property State Superfund Site ("Potts Site") to the east. Several industrial businesses operate on the adjacent Potts Site. Each of the properties surrounding the Halby Chemical Site is zoned either M-2 or M-3 for general or heavy industrial use. All of the property between I-495 and the Port of Wilmington, along the Terminal Avenue corridor, is zoned for industrial or commercial land use. Based on these and other factors, EPA determined that industrial use is the most reasonable land use to consider when evaluating the risk presented by the Site and developing an appropriate remedial action.

However, for clarity, EPA notes that the asphalt capping remedy may also be acceptable for retail, commercial or other specific uses should the stakeholders determine a land use change is appropriate. The substantive restrictions for future use of the property relate to preventing exposure to contaminated soil and sediment; therefore, maintaining the integrity of the cap is paramount. A mechanism will be established to ensure that workers are aware of the presence of hazardous substances beneath the cap so they are properly trained and protected during any subsurface construction work necessary at the Site.

5. A citizen asked what year the first ground water problems occurred.

EPA Response: EPA first became aware of ground water contamination when the Site Inspection was performed in March 1984. It is not known exactly when, or how, ground water beneath the Halby Chemical Site first became contaminated because it was not being monitored prior to 1984. Current ground water analyses confirm the presence of several compounds and inorganic contaminants which are found at concentrations unsafe for human consumption. Ammonia, carbon disulfide, thiocyanate and arsenic can be linked to past operations at the Halby Chemical plant as these are substances known to have been utilized by plant production activities. It follows that the ground water likely became contaminated by these compounds after the plant began operations in 1947. Other substances, such as manganese, have not been linked to Halby Chemical operations based on information known to EPA, and therefore their presence may pre-date the Halby plant operations.

6. A citizen asked if there are any water lines running through the Site and opined that any public water lines should be re-routed.

EPA Response: Yes. A 16-inch diameter water main owned by the United Water Company runs approximately 15 feet from, and parallel to, the railroad tracks. According to the United Water Company, the water main does not service any residential areas, but does service industrial client(s) located at the Port of Wilmington. The presence of the water main had been one of EPA's primary concerns specifically related to the subsurface carbon disulfide contamination located within the area referred to as the carbon disulfide treatment zone.

In accordance with the Unilateral Administrative Order for a Removal Action (EPA Docket No. III-95-55-DC), Witco Corporation performed several investigations focusing on the water main. Soil sampling and analyses adjacent to the water main indicates that the high concentrations of carbon disulfide did not extend to the water main (high concentrations of carbon disulfide have now been removed through the chemical oxidation process). In addition, a specialized Site Corrosion Survey/Investigation of the 16- inch diameter water main was completed by RAM Services in June 1996. In summary, the investigation exposed the water main at two locations nearest the carbon disulfide treatment zone and subjected the pipe to visual inspection and ultrasonic thickness testing. The pipe was observed to be tightly encased in a plastic wrap. At both locations, the plastic wrap was removed to allow visual inspection of the pipe. The pipe was observed to be in excellent condition. The pipe wall was measured to be at least 0.65 inches thick. Several additional measurements were collected to determine the corrosivity of the environment, including soil resistivity, and the presence or absence of D.C. stray current to determine structure-to-soil and structure-to-electrode potentials. The findings of the pipe investigation report stated that no special repair, maintenance and/or upgrading are necessary at the time of the survey. It was suggested that installation of sacrificial anodes be considered for corrosion control to prolong the useful life of the waterline. According to Witco Corporation, the full report was submitted to United Water Company. In consideration of the findings of the water line investigation, the integrity of the water line traversing the property is sound. The asphalt cap to be constructed in accordance with the Selected Remedy will extend over the pipe. United Water Company is aware of Site-related contamination in the vicinity of the water main. Workers performing future subsurface maintenance activities on the Halby Chemical Site must meet Occupational Safety and Health Administration ("OSHA") standards set forth at 29 C.F.R. 1910.120 governing worker safety.

7. A citizen asked the following questions regarding the location of carbon disulfide. How much carbon disulfide is on the Site? Is the carbon disulfide perched on an impermeable clay layer? How deep into the ground has the carbon disulfide gone?

EPA Response: Prior to the carbon disulfide treatment project, which was completed in January 1998, more than 40 test pits and one hundred soil borings were used to delineate carbon disulfide contamination on the property. The field investigations delineated approximately 11,000 cubic

yards of contaminated soil containing an average of 4,000 mg/kg carbon disulfide. The bulk of carbon disulfide was located between 4 and 12 feet below the ground surface. A natural gray clay layer occurs approximately 12-14 feet below the surface and appears to have reduced the vertical migration of carbon disulfide. The treatment program successfully removed carbon disulfide in the uppermost 12 feet of soil to less than 300 mg/kg.

Although no evidence of free phase carbon disulfide below the gray clay layer has been documented, it is very possible that some dense non-aqueous phase liquid ("DNAPL") has migrated into the Columbia formation between the 12-30 feet level. Dissolved phase carbon disulfide has been detected in the Upper Potomac Aquifer beneath the carbon disulfide treatment zone at concentrations several orders of magnitude lower than measured in the Columbia aquifer. The Upper Potomac aquifer extends to 70 feet below the ground surface. In addition, carbon disulfide has been measured in lagoon and marsh sediments. The highest concentration of carbon disulfide in sediments occurs at the location identified as the "Bio-7" station used for conduct of bioassay sampling. The Bio-7 station was found to be highly toxic to aquatic life, resulting a 100% mortality rate.

8. A citizen asked how the carbon disulfide was found on the Site.

EPA Response: EPA has been aware that Halby Chemical used carbon disulfide as a precursor compound for production of sulfur-based compounds at the facility. Sampling activities performed during conduct of the first operable unit Remedial Investigation detected carbon disulfide in relatively localized areas in lagoon surface water, tidal marsh sediment (Bio-7 area), and sediment within the former process plant drainage ditch. In 1995, EPA drained approximately 10,000 gallons of carbon disulfide from an above-ground storage tank (Tank #4) located at the terminal end of the railroad spur servicing the Site. The primary source of carbon disulfide in the environment was identified in 1995 when EPA contractors removed subsurface drainage pipes associated with the former chemical production plant, including a subsurface discharge pipe from Tank #4. The free-phase carbon disulfide was delineated through a focused sampling program.

9. A citizen asked if arsenic is moving into the Christina River either through surface water or ground water discharge and creating a toxic condition for fish.

EPA Response: Delaware has established State Surface Water Quality Standards for the protection of aquatic life in both freshwater and marine systems. The most stringent standard for arsenic is the marine chronic criterion which is established at 36 micrograms per liter (ug/l); the freshwater chronic criterion is 190 ug/l. Surface water samples collected in the Christina River do not contain arsenic at concentrations greater than 36 ug/l. The only location in the vicinity of the Halby Chemical Site where surface water analysis has documented concentrations greater than 36 ug/l is the on-Site lagoon. A sample collected from the on-Site lagoon was found to contain 597 ug/l.

B. CONTAMINANTS AND HEALTH RISKS

1. A few citizens asked what symptoms or diseases carbon disulfide exposure causes.

EPA Response: Carbon disulfide is not a suspected carcinogen. However, according to the Integrated Risk Information System ("IRIS") database (EPA/March 1997), carbon disulfide is a systemic toxicant. The primary target organ for carbon disulfide exposure is the central nervous system, but effects on the cardiovascular and ocular systems have also been observed. Some of the symptoms which could be caused by exposure to excessive concentrations of carbon disulfide include headaches, tiredness, tremors, changes in nerve function, vision problems, difficulty breathing, and chest pains. These symptoms have been observed by studies on workers primarily in the viscose rayon industries.

2. A citizen asked the following questions regarding the properties of carbon disulfide. Is carbon disulfide a liquid? Does carbon disulfide mix with water? Is carbon disulfide heavier than water?

EPA Response: Carbon disulfide is a liquid at temperatures found below the ground surface. The boiling point of carbon disulfide is approximately 116 degrees Fahrenheit. Similar to oil, carbon disulfide is non-polar and therefore does not mix well with water. Although carbon disulfide is considered to be insoluble in water, a very small fraction of carbon disulfide will dissolve in water. Carbon disulfide is approximately 1.3 times denser than water and is, therefore, heavier than water.

3. A citizen asked if arsenic, cadmium, copper, mercury and zinc are present in the soil at levels above natural background. As a follow-up question, the citizen asked if these metals pose an elevated risk to human health.

EPA Response: Yes, arsenic, cadmium, copper, mercury and zinc are present in the Site soil at levels higher than concentrations considered by DNREC to be representative of natural background concentrations in Delaware soil. Each of these metals occur naturally in all soil. Almost the entire Halby Chemical Site is comprised of fill material which was placed over tidal marsh during the early 1900's. The source of these fill materials is not known to EPA. Only arsenic has been found in Site soil at levels high enough to present unacceptable human health risks. Cadmium, copper, mercury and zinc are not considered to be contaminants of concern with respect to Site soil, however, each of these metals is found in Site sediments at levels above those known to be protective of aquatic life.

4. A citizen asked if arsenic and cadmium are carcinogenic.

EPA Response: Arsenic is a known human carcinogen that causes skin or lung cancer. This information was obtained by studying smelter workers who were exposed to high levels of arsenic for a long period of time. Arsenic also causes darkening of the skin, the appearance of "corns" on the palms and soles, skin lesions, and blood vessel damage. These noncancer effects

were noted in human populations who were exposed to arsenic in their drinking water over a long period of time.

Cadmium is considered to be a "probable" human carcinogen that may cause lung cancer if it is inhaled. It is classified as a "probable" carcinogen because the cadmium smelter workers who were studied were also exposed to arsenic, making it difficult to separate the effects of one chemical from the other. Long-term exposure to cadmium may also effect the kidney, leading to the presence of excess protein in the urine.

5. A citizen asked if the compounded effect of the metals were considered or if they were examined individually when the study of the Site was conducted.

EPA Response: Briefly, both the noncancer and cancer risks for potential exposure to Site-related metals were determined. The risks for exposure to each metal were initially determined. The noncancer risks from metals that were thought to have similar effects on target organs, for example, central nervous system disorders, were added together. The cancer risks due to metals were added together, regardless of the organ from which the cancer might originate. Therefore, noncancer risks are considered additive if the target organ is the same and cancer risks are always considered additive. It should be noted that some studies indicate that simultaneous exposure to certain metals can lead to a chemical interaction that causes the effects of two or more chemicals to be either more (synergistic) or less (antagonistic) than the sum of each response. This type of interaction between Site-related metals was not considered in the ecological or human health risk assessments. Ecological and Human Health Risk Assessments were conducted during the Remedial Investigation, and more fully identify carcinogenic and non-carcinogenic risks posed to human health and the environment.

6. A citizen asked if there was a fire and explosion on the Site during cleanup operations. He followed up by asking if mixing carbon disulfide with water increases its flammability.

EPA Response: There were two flashes of fire during sampling activities caused by ignition of concentrated carbon disulfide vapors within sampling trenches. Ignition of carbon disulfide vapors behave as a single flash, similar to lighting a barbeque grill, and did not create a sustained fire.

Carbon disulfide vapors in the 1.3 - 50% concentration range are potentially explosive in the presence of oxygen (or air which includes oxygen). Mixing carbon disulfide and water does not increase its flammability. By mixing carbon disulfide and water, the two liquids separate into layers. Carbon disulfide will become the bottom layer because carbon disulfide is denser, and therefore, heavier, than water. When an industrial company transports or stores carbon disulfide, it is always shipped with a layer of water across the top. The water becomes a protective barrier by preventing carbon disulfide liquid from moving into the air as a vapor.

Most of the carbon disulfide that had been present within the carbon disulfide treatment zone was actually located below the water table. The ground water acted as a natural barrier shielding the carbon disulfide from an oxygen source and preventing it from reaching the air at the ground

surface. By treating the carbon disulfide in place, potential for vapor release and explosion was minimized. Nevertheless, several small flashes were ignited within the protective vapor hood during the treatment process. The hood contained the flash and captured the carbon disulfide vapors. The captured vapors were continuously routed to an air treatment unit.

C. POTENTIAL PAST EXPOSURE AND HISTORICAL ISSUES

1. A few citizens asked if there have been adverse health affects to people who lived near the Halby Chemical plant during the years that the plant was releasing hazardous substances to the environment.

EPA Response: No epidemiologic studies have been conducted in the community surrounding the Halby Chemical Site. All citizen inquiries regarding potential past exposure at the Site have been forwarded to the Agency for Toxic Substances and Disease Registry ("ATSDR") for follow-up. ATSDR is a Federal agency within the Department of Health and Human Services that, in conjunction with EPA, is responsible for implementing health-related authorities of Superfund. This includes conducting site-specific health assessments and/or epidemiologic studies, investigating the potential health effects of the Site on area residents potentially exposed to Site-related contaminants. In coordination with DNREC, an ATSDR representative has spoken with individuals who have raised concerns about potential past exposures at the Site and has provided health-related information to the residents. ATSDR will continue to work with the Delaware Department of Public Health to evaluate the need for additional actions based on any new information that develops. In the interim, EPA will proceed to take all necessary action to prevent prospective exposures to Site-related contaminants to ensure protection of human health and the environment.

2. A resident expressed concern that citizens who may have been exposed to contaminants during plant operations are not being educated about the potential risks of past exposure.

EPA Response: In responding to the potential threat to human health and the environment presented by the Halby Chemical Site, EPA has focused on current and future conditions. It is very difficult and, in many cases impossible, to predict potential health effects caused by chemical exposures which may have occurred 20-50 years ago. This difficulty is a result of the lack of adequate records concerning the specific chemical make-up, concentration, and quantity of these past releases. ATSDR and DNREC representatives have discussed these issues with a few residents who believe they may have had significant past exposure and will continue to do so at the residents' request. The current ATSDR contact person for the Halby Site is Mr. Jack Kelly. Mr. Kelly may be contacted at (215) 566-3141 or via mail at 841 Chestnut Street, Philadelphia, Pennsylvania 19107.

3. A citizen who lived in a house which was located on a parcel adjacent to the Halby Chemical plant during the period spanning from the 1940' s through 1954 expressed concern of the potential health effects to her family from drawing drinking water from a private drinking water well. Another citizen who is a member of the family which bought the farm house in 1954 and lived there for approximately ten years expressed the same concern. She stated that

at some point during their ownership her father connected the house to public water. Members of both families asked if it is correct to assume that they had been exposed to contaminated ground water from the private well.

EPA Response: It is impossible to state definitively whether the water withdrawn from the private water well was contaminated or not during the 1940's and/or 1950's. However, ATSDR and the Delaware Department of Public Health have and will continue follow up on the inquiries. Although the health agencies cannot determine that a given current health problem was caused by past Site-related exposure, they can provide useful information about the known adverse health conditions caused by Site-related chemicals and can direct individuals to private, experienced medical facilities should there be a firm belief that a health problem was caused by chemical exposure.

Citizens who have concerns about health effects due to past exposure to Site contamination should contact Mr. Jack Kelly of ATSDR at (215) 566-3141 or via mail at 841 Chestnut Street, Philadelphia, Pennsylvania 19107.

4. A resident commented that years ago the residents complained to the Federal government about the problems at this Site and no one ever responded to the complaints.

EPA Response: There was no legal authority for direct Federal response to environmental hazards until 1980. In 1980, Congress enacted the Comprehensive Environmental Response, Compensation and Liability Act ("CERCLA"). CERCLA gave the Federal government the authority to respond to emergencies involving uncontrolled releases of hazardous substances and to make the responsible parties pay for the response. The media and concerned citizens played an important role in getting the federal environmental laws enacted. Delaware DNREC records document that the State public health officials conducted numerous site inspections during the period that the chemical plant operated, several in response to citizen complaints. State officials worked to enforce compliance with the laws that existed at the time.

5. A citizen who once lived near the Site stated that EPA is in error by stating that the Halby Chemical plant began operations in 1947. Her father bought land nearby in 1943 and the plant was in full operation at that time.

EPA Response: The deed search on the property concluded that Albert and Anna Beekhuis purchased the parcel that the chemical plant was built on from the Lobdell Company on February 4, 1946. Dr. Albert Beekhuis is the founder of the Halby Chemical Company. Dr. Beekhuis conveyed the said property to the Halby Chemical Company on May 7, 1948. Information in EPA's possession indicates that the plant began operations in 1947.

D. IMPLEMENTATION AND EFFECTIVENESS OF REMEDIATION PLAN

1. A citizen asked if EPA's proposed clean-up methods are reliable.

EPA Response: Yes, the construction methods proposed for this Site are well-tested and reliable. Capping contaminated soil/sediment is a proven technology that has been successfully implemented to prevent exposure to underlying wastes at thousands of landfills and other environmentally compromised properties. The soils located on the adjacent residential parcel containing greater than 14 mg/kg arsenic can be effectively identified through sampling. The delineated soils can reliably be excavated and consolidated beneath the cap. EPA has a high degree of confidence that the implementation of the Selected Remedy will reduce the potential risk to human health and the environment associated with exposure to contaminated soil and sediment. In addition, environmental engineers and scientists have successfully designed and constructed wetlands at many locations.

2. A citizen asked if EPA is going to eliminate the current human health hazards presented by the Site.

EPA Response: EPA has selected a remedial strategy that, when completed, will prevent unhealthy exposure to Site-related contamination. The chemical plant is no longer in operation, therefore chemicals are not being released to the environment as part of the day-to-day routine. Currently, an unacceptable human health risk is presented to Site workers who might dig in the surface soil or sediment and, to a lesser degree, trespassers, who come directly in contact with contaminated soil or sediment. In addition, elevated risk is potentially posed to residents living on the residential parcel adjacent the Site. The majority of risk is presented to persons who inadvertently eat small amounts of soil and/or sediment on a daily basis. After implementation of EPA's Selected Remedy, Site workers and trespassers will no longer be at increased risk. A protective cap will be constructed to prevent the possibility that people or environmental receptors will come into contact with elevated levels of Site contaminants. Prior to cap construction, soils on the residential property containing greater than 14 mg/kg arsenic will be consolidated and placed beneath the cap. Implementation of the Selected Remedy will reduce the excess lifetime cancer risk to less than 10^{-5} and a Hazard Index of less than 1.0; these are within the range which represent EPA's risk reduction goals for carcinogens and non-carcinogens.

3. A citizen stated that perimeter monitoring is important.

EPA Response: The Selected Remedy does include provisions for both long-term environmental monitoring and periodic reviews. A long-term monitoring plan, including sampling of ground water, will be implemented. In addition, EPA will conduct a review of the Halby Chemical Site no less than every five years. The review is designed to ensure that the remedy remains protective of human health and the environment. The requirement to conduct periodic reviews is

a standard component in any remedy which includes on-Site containment, such as the capping of contaminated soil and sediment.

4. A citizen asked if any part of the Site will be raised above its original level.

EPA Response: Yes. The lagoon and marsh area will be filled to prevent potential for exposure to contaminated sediments. The Site will be graded to provide proper drainage. Contaminated soil on the Site and the lagoon surface will be paved. The average surface elevation of the property will be raised as result of the cap installation.

5. A citizen asked if the potential for Site-related contaminants to degrade the water quality of the Christina River was factored into the clean-up plans.

EPA Response: Yes. There are two potential migration paths from the Halby Chemical property to the Christina River: fast moving surface water and slow moving ground water. The surface water exposure pathway will be addressed by the Selected Remedy. The potential for ground water related impacts to the river will be addressed by Delaware DNREC as part the Potts Property State Superfund Site response action.

The affected waterways (i.e., the tidal marsh and, until recent construction of a berm, the on-Site lagoon) are flushed two times each day by tidal flux. The water flushing out of these water bodies can transport both dissolved contaminants and contaminated sediments into the Christina River. As identified in the Remedial Investigation, the lagoon and marsh are both sources of contaminated sediment and locations where dissolved contaminants found in the ground water can be released to the surface water. Covering the marsh and lagoon will prevent the daily contribution of contaminants to the Christina River via surface water. Research has consistently shown that wetlands associated with river environments are important to both water quality and habitat vital to a healthy riverine ecosystem. Creation of wetlands at an off-Site location will replace important habitat which has been lost due to backfilling of wetlands at this Superfund Site.

Potentiometric mapping suggests that ground water in the Columbia and Upper Potomac Aquifers moves east-northeast and discharges to the Christina River approximately 2,000 feet distant. As the ground water/surface water interface occurs on the Potts Property State Superfund Site, EPA and DNREC have concluded that a study of the potential affect of ground water discharge to the Christina River can only be performed as part of the Potts Site investigations. If the investigation determines that the ground water discharge presents an unacceptable risk to human health or the environment, Delaware DNREC will evaluate the options for protecting the river and propose a Plan of Remedial Action. In the event that contaminants originating at the Halby Chemical property are found to be traversing the 72-acre Potts Site and contributing to an unacceptable risk, Delaware's Hazardous Substance Control Act provides the legal authority for DNREC to join the Halby Chemical PRPs in the Potts Site remediation plan.

6. A citizen commented that a well system should be installed to contain ground water contamination at the Site.

EPA Response: EPA did evaluate installation of recovery well networks as a potential means of preventing ground water contaminants from migrating beyond the waste management area, the property boundary. The objective of a ground water containment system is to operate a series of recovery wells which collectively create a ground water divide. Ground water is extracted from each of the wells at a rate that prevents water-borne contaminants from flowing past. The standard practice is to install the recovery well network along the downgradient border of the waste management area. The goal is to create an "area of attainment" just downgradient of the recovery well network, beyond the ground water divide. The area of attainment is the zone where ground water cleanup standards will be met if the ground water divide is maintained, thereby preventing water-borne contaminants from moving into the area.

A fundamental principle in designing this "net" of recovery wells is to place the wells downgradient of all contaminant sources. With the 72-acre Potts Site immediately downgradient of the Halby Chemical property the actual waste management area, for all practical purposes, extends to the Christina River. Installation of a recovery well network focusing on the Halby Chemical Site would not create an area of attainment, a zone of clean water, due to the presence of several hundred thousand cubic yards of metals-laden fill material on the Potts Site.

Scientists, engineers and environmental policy managers considering the matter have concluded that designing and installing a recovery well network that only accounts for the Halby Chemical Site is not practical because no environmental benefit would be realized though its operation. Further, the design, installation and operation of such a system is estimated to cost between $12 and $30 million depending on whether the recovered ground water is reinjected to ground or discharged to the surface water after treatment in an abatement facility to be constructed on the property. All this effort would have been spent without the achievement of a measurable environmental benefit. EPA and DNREC have determined that the intermingled contaminants will be most appropriately evaluated and addressed at the downgradient edge of the Potts Site. Accordingly, Delaware DNREC will retain the lead role in evaluating and addressing the ground water, as the Potts Site is a State Superfund Site.

EPA's Selected Remedy acknowledges the ground water management zone established by Delaware DNREC encompassing the Halby Chemical Site, the Potts Property State Superfund Site and the Port of Wilmington and environs and includes maintaining an active monitoring program. The ground water management zone eliminates the potential for future exposure to ground water by ensuring that no public or domestic water supply wells are permitted in any aquifer beneath the Halby Chemical and Potts Property State Superfund Sites. Further, EPA will establish deed restrictions on the parcels comprising the Site in conformance with DNREC's ground water management zone. Monitoring of ground water in the Columbia, Upper Potomac and Lower Potomac Aquifers will be conducted to track Site-related contamination over time. In addition, EPA will conduct a review of the Halby Chemical Site no less than every five years. The review is designed to ensure that the remedy remains protective of human health and the environment. The requirement to conduct periodic reviews is a standard component in any remedy which includes on-Site containment, such as the capping of contaminated soil and sediment.

7. Several residents commented that they thought capping the Site was just covering the problem instead of solving the problem.

EPA Response: EPA is tasked with identifying risks presented by an environmentally compromised site and evaluating a full range of options to reduce the identified risks. At the Halby Chemical Site EPA orchestrated a variety of response actions to manage risks identified by the Site. Conditions determined to pose the most immediate potential hazards were dealt with on a time-critical basis. The former chemical plant was expeditiously decontaminated and dismantled. Chemicals removed from the abandoned chemical laboratory, reaction vessels, processing equipment, and chemical storage tanks and containers were properly packaged and transported to approved facilities for treatment and/or disposal. The highly concentrated mass of carbon disulfide found to extend from beneath the former aqueous discharge pipe was treated in place using an innovative *in situ* chemical oxidation process to convert the carbon disulfide to innocuous end-products. The remedy selected in the Record of Decision focuses on reducing long-term risk presented by the lower concentrations of inorganic contaminants spread across a large area. The CERCLA statute specifies nine criteria which are to be used to compare the viable options to reduce the risks a site presents to human health and the environment. Upon full consideration of each of the remedial alternatives measured against the nine criteria EPA has determined the best remediation strategy for addressing remaining residual contamination to be the implementation of engineering controls (cap) to prevent exposure to contaminated sediments and soil.

8. A citizen asked if Site construction activities will have an adverse effect on the air quality by entraining arsenic-tainted dust particles.

EPA Response: A Health and Safety Plan will be developed as part of the Work Plan to identify standard protocols necessary to prevent the generation of dust during Site construction activities. All construction activities will be conducted in accordance with the Site Health and Safety Plan. Air monitoring will be conducted to confirm the effectiveness of dust suppression methods utilized.

9. A citizen asked how much carbon disulfide will remain in the soil after the clean up.

EPA Response: The goal established during the removal action was to treat the uppermost 12 feet of soil to achieve an average carbon disulfide concentration of 1,010 mg/kg. Although 1,010 mg/kg carbon disulfide was the treatment goal, post-treatment sampling has confirmed that the treatment program was more successful than anticipated and an average concentration of less than 300 mg/kg was achieved. In terms of hazard reduction, achieving 300 mg/kg carbon disulfide in soil reduces the calculated hazard index to approximately 0.1 which is one-tenth of EPA's standard hazard index goal. A hazard index is how EPA calculates the potential hazard posed by non-carcinogenic compounds. If the Hazard Index exceeds 1.0, there may be concern for the potential non-carcinogenic health effects associated with exposure to the chemical. See Response A.7 for distribution of carbon disulfide prior to implementation of treatment project.

10. A citizen asked if there are going to be storm water run-off controls for the capped area.

EPA Response: The cap design will include a storm water and sediment control plan which meets the substantive requirements of the Delaware Sediment and Stormwater Regulations. In addition to ensuring that the proper controls are in place to control storm water runoff during construction activities, the storm water management plan will also address post-construction storm water management. The general intent of the storm water management plan will be to design the remedy in a manner that the post-construction runoff rate does not exceed the pre-construction runoff rate when considering various hypothetical storm events based on past weather data. The specifics of the plan will be determined in the design; however, it is likely that the plan will include a storm water retention basin(s) which collects runoff during the rain event and releases it at a controlled rate.

E. SUPERFUND PROGRAM AND PROCESS

1. A citizen asked if any of the sites in Delaware have been cleaned-up and removed from the National Priorities List.

EPA Response: Of the 20 Delaware sites which have been included on the National Priorities List ("NPL"), 12 have had construction activities associated with the cleanup completed. Of those 12, three sites have been deleted from the NPL: New Castle Spill Site, New Castle Steel Site, and Sealand Limited Site.

2. A citizen asked if EPA's clean-up decisions can be appealed.

EPA Response: EPA has demonstrated a willingness to modify cleanup decisions when warranted based on new information and technical merit. EPA's decision-making process provided for public involvement and meaningful comment before the final cleanup decision was made. EPA and the State seriously considered public input as one of the nine criteria used to select the remedy. Once a cleanup decision is made, EPA moves to implement the selected cleanup plan as expeditiously as possible. It is EPA's intent to act to minimize risks presented by the Site in a timely manner. At the same time, EPA will maintain an open door policy to listen to stakeholder concerns even after the Record of Decision has been issued.

3. A citizen asked if a Technical Assistance Grant ("TAG") group needs to be incorporated.

EPA Response: Yes, the group must be incorporated before they receive the grant. EPA is available to assist groups seeking a TAG.

4. A citizen asked if EPA has discussed the existence of EPA's TAG program with the community.

EPA Response: Yes. EPA representatives routinely included a discussion of TAG grants when speaking to citizens or groups about the Halby Site. Discussions become more detailed when the group or individual expresses an interest in learning more. The first TAG application package EPA sent to a group specifically interested in applying for a TAG at the Halby Chemical Superfund Site was 1993. After preliminary discussions related to the TAG program, that particular group did not formally initiate the TAG application process by submitting a letter notifying EPA of its intent to apply. Most recently, EPA has participated in numerous discussions relating to the TAG program with representatives of the Wilmington River-City Committee. The Waterfront Coalition has expressed an interest in administering a TAG grant dedicated to the Halby Chemical Site. The Waterfront Coalition submitted a Halby Chemical TAG application in December 1997. EPA reviewed and provided comments on the draft application in January 1998 is currently working with the Waterfront Coalition to complete the application and, as appropriate, grant award process.

5. A citizen asked how the state is involved in the TAG process.

EPA Response: All grants are subject to intergovernmental review. This means that, if the State requires it, the grant receipient must provide it with an opportunity to review the grant application. This process may be used to keep the Governor informed about the variety of grants awarded within the state. State requirements regarding this review vary; typically, the applicant submits a copy of the grant to the state intergovernmental review contact. In Delaware, the contact is Francine Booth, Executive Department, Dover, Delaware.

States may require up to 60 days for the intergovernmental review process. Therefore, a copy should be sent to the State at the same time the application is submitted to EPA.

The Intergovernmental Review of Federal Programs fulfills Executive Order 12372, (July 14, 1982). The regulations applicable to this Executive Order can be found in the Code of Federal Regulations at 40 C.F.R. Part 29. 40 C.F.R. § 29.1(b) states these regulations are intended to foster an intergovernmental partnership and a strengthened federalism by relying on State processes and on State, areawide, regional and local coordination for review of proposed Federal financial assistance and direct Federal development.

6. Several citizens expressed concern that the cleanup process is too slow and noted that current workers on the Site may be exposed to contaminated soil while lengthy planning phases are being completed.

EPA Response: EPA agrees that the cleanup should proceed as expeditiously as the Superfund process will allow. EPA did complete "removal" assessments to identify and address the most significant potential threats presented by the Site on an immediate basis. EPA utilized its removal authorities to isolate the on-Site lagoon from the Christina River, decontaminate and dismantle the former chemical production facility, and delineate and remove high concentrations of subsurface carbon disulfide. EPA intends to take all appropriate action to ensure that remaining cleanup activities are completed in an efficient and safe manner.

Copies of the Remedial Investigation, including Risk Assessments, have been provided directly to the Halby Chemical Site property owners. The majority of risk presented to Site workers is due to incidental ingestion of contaminated soil. The Site owners have been advised to stress good hygiene practices (i.e., clean hands often and always before eating, eating lunch indoors, etc.) to minimize exposure to all employees.

7. A citizen requested that EPA halt the Halby Chemical clean-up process until the community has adequate time to hire their own technical expert for the Site.

EPA Response: The majority of citizens commenting on the cleanup process at Halby Chemical believe that the cleanup has proceeded too slowly and are not in favor of halting the process. EPA believes that the cleanup should proceed as expeditiously as the Superfund process will allow. In the event that a citizen group does decide to administer a Technical Assistance Grant and hire an expert to interpret and explain Site related information, EPA will include the TAG advisor in the process without slowing the Site remediation.

F. ENFORCEMENT

1. A citizen asked about the role of the Potentially Responsible Parties (PRPs).

EPA Response: A PRP is an individual or company potentially responsible for contributing to the contamination at a site. In accordance with CERCLA, PRPs may be obligated to implement response actions deemed necessary by EPA to protect health, welfare or the environment, and may be liable for all costs incurred by the government in responding to any release or threatened release at the site. To date, work at the Site has been conducted both by the Brandywine Chemical Company and Witco Corporation, as well as the Federal government. It is EPA's expectation that the Halby Chemical PRPs will agree to implement the Selected Remedy. In the event that the Halby Chemical PRPs choose not to consent to implement the Selected Remedy, EPA may, (1) compel the PRPs to perform the work through administrative and/or legal actions, or (2) utilize federal monies to perform the necessary work and subsequently pursue the PRPs for reimbursement of the response costs through legal action.

If a PRP(s) does agree to perform response activities at the Halby Chemical Site, the PRP(s) will prepare a work plan detailing how activities will be completed. EPA and DNREC will review and comment on all planning documents. The work plans must be accepted by EPA before activities can take place on the Site. During actual performance of the work, EPA and DNREC will monitor the ongoing work to confirm that the activities are being implemented in conformance with the EPA-approved plan.

2. A citizen asked why the PRPs are not required to use the most expensive clean-up methods. Another citizen asked how much it would cost to implement the most expensive clean-up option.

EPA Response: We must first recognize that Superfund Sites, in general, became contaminated at a time period proceeding the promulgation of environmental laws. Most properties which have been placed on the National Priorities List, including the Halby Chemical Site, became degraded due to unsafe chemical handling and disposal practices which were commonly used as standard operating practices throughout the chemical and manufacturing industry prior to 1976. The cleanup action is not intended to be punitive, but rather a corrective action to reduce elevated risks presented to human health and the environment.

Once the risks presented by a site are identified, all plausible options for reducing the identified risks are developed. EPA evaluates, compares and contrasts each option using the nine evaluation criteria when determining clean-up plans. When weighing the various cleanup options against the nine criteria it becomes apparent that the best plan to reduce risk presented by a degraded site is not always the most expensive. For example, it would cost approximately $155 million to subject the Halby Site to the most expensive combination of media-specific remedial options developed. The end result appears to be the same level of risk reduction as the Selected Remedy, which can be achieved at a cost of less than $10 million. When evaluating the options against the nine criteria, each of the options evaluated must meet the threshold criteria Overall Protectiveness and Compliance with ARARs. The Selected Remedy compares favorably to the combination of most expensive media-specific remedies when considering Short-term Effectiveness, Implementability, and Cost. On balance, the Selected Remedy represents the best combination of media-specific cleanup options when compared against the nine criteria. A discussion of the cleanup options may be found in the Feasibility Study as well as this ROD.

In addition, the most expensive options for soil (S-4: Soil Washing - $27,300,000) sediment (LM-3: Sediment Stabilization, Cap lagoon, Backfill Marsh, Create Wetlands Off-Site - $44,600,000) groundwater (G-5: Extract and Treat Ground water, Reinject to Ground Water, Institutional Controls - $30,200,000) and potential DNAPL (D-3: Slurry Wall, Inject Surfactant, Extract and Treat Surfactant and DNAPL - $54,200,000) often compare unfavorably against the Selected Remedy when considering the remaining criteria.

3. A citizen asked why the government is paying for the clean-up of the Halby Site.

EPA Response: Reference the response to question F.1, above, for the options EPA has in completing response actions at a Superfund site. At the beginning of each planned action, EPA has provided companies who have been identified as PRPs (based on information in EPA's possession at that time) the opportunity to perform the respective response action. Witco Corporation, a past owner/operator of the Halby Chemical facility, has agreed to conduct the Remedial Design and Remedial Action selected in the first operable unit ROD[1] and, also, to perform the removal actions necessary to address subsurface carbon disulfide contamination. Brandywine Chemical has undertaken some liquid chemical removal from tanks and permitted access to the Site under an agreement with EPA. When PRPs declined to perform each of the Remedial Investigations and Feasibility Studies as well as the first phase of the removal action EPA opted to use federal monies from the Superfund to finance those activities. The first phase

[1] OU-1 design activities have been suspended due to a change in Site operations and will be incorporated into this Record of Decision.

of the removal action included the decontamination and dismantlement of the former chemical production facilities. EPA intends to pursue the PRPs for reimbursement of its past response costs through settlement negotiations or, if necessary, through legal action.

4. A citizen asked if the cost of the carbon disulfide program was included in EPA's $9,700,000 cost estimate to implement the preferred alternative identified in the Proposed Plan.

EPA Response: No, EPA did not include the costs incurred by Witco Corporation in the cost estimate for prospective work outlined in the Proposed Plan. Witco is not required to notify EPA of its response costs; however, EPA estimates that the work cost Witco approximately $3,500,000. In addition, EPA incurred approximately $1,500,000 in response costs during decontamination and dismantlement of the chemical production facility in 1995 and has incurred more than $3,000,000 in response costs to conduct the two Remedial Investigations and Feasibility Studies. These past response costs are also excluded from the $9,700,000 projected to complete the Selected Remedy.

G. Communication of Site Related Information

1. A Wilmington city council representative asked if the state and Federal agencies are communicating with each other regarding reponse actions being performed at the Halby Chemical Site and the adjacent Potts Property State Superfund Site. Specifically, the representative asked how the Federal and state agencies plan to handle the overlap created by the ground water containing contaminants from both sites being intermingled.

EPA Response: Yes, EPA and Delaware DNREC are communicating with and cooperating with one another. The Halby Chemical Site was listed on the National Priorities List in accordance with federal criteria. EPA has taken the lead role in characterizing and responding to the Halby Chemical Site; Delaware DNREC has participated in every aspect of the planning and response as a support agency. All environmental data and reports have been provided to Delaware DNREC for joint review. Seven of the monitoring well locations used to characterize ground water in the vicinity are located on the Potts Site.

EPA approached the ground water investigation at the Halby Chemical Site as a separate investigation and developed options to remediate ground water independent of the down-gradient Potts Site. Upon thorough evaluation, it has become apparant that taking a response action to prevent contaminated ground water from moving beyond the Halby Site property boundary would realize no measurable environmental benefit. Due to the presence of hundreds of thousands of cubic yards of metal-laden fill material on the 72-acre property, the ground water beneath the Potts Site would remain unfit for human consumption even after EPA mandated the expenditure of millions of dollars to contain ground water at the Site boundary. EPA and DNREC are in accord that the intermingled contaminants from both sites must be addressed collectively to realize environmental benefit.

Additional data will be collected under the direction of DNREC pursuant to the Remedial Investigation of the adjacent Potts Property State Superfund Site, including an evaluation of

ground water and potential contaminant flow at the Christina River interface. In the event that the Potts Site investigation determines that contaminated ground water discharging to the Christina River presents an unacceptable risk to human health or the environment DNREC will evaluate the options for protecting the river and propose a Plan of Remedial Action.

Since the Potts Property State Superfund Site was listed by the State of Delaware in accordance with state criteria, EPA does not have a formal role in the Potts Site planning and response actions. However, EPA will follow the progress of the ground water evaluation and will continue to cooperate with DNREC by providing all environmental data and technical and legal assistance as appropriate. If action is warranted to reduce ground water discharge to the Christina, DNREC is not precluded from pursuing Halby Chemical PRPs for contribution.

EPA's Selected Remedy acknowledges the ground water management zone established by Delaware DNREC encompassing the Halby Chemical Site, the Potts Property State Superfund Site and the Port of Wilmington and environs and includes maintaining an active monitoring program. The ground water management zone eliminates the potential for future exposure to ground water by ensuring that no public or domestic water supply wells are permitted in any aquifer beneath the Halby Chemical and Potts Property State Superfund Sites. Further, EPA will establish deed restrictions on the parcels comprising the Site in conformance with DNREC's ground water management zone. Monitoring of ground water in the Columbia, Upper Potomac and Lower Potomac Aquifers will be conducted to track Site-related contamination over time. In addition, EPA will conduct a review of the Halby Chemical Site no less than every five years. The review is designed to ensure that the remedy remains protective of human health and the environment. The requirement to conduct periodic reviews is a standard component in any remedy which includes on-Site containment, such as the capping of contaminated soil and sediment.

2. A citizen asked EPA and DNREC to communicate with the community on current issues and asked where to go to get additional information about the Site.

EPA Response: EPA and DNREC representatives will make every effort to keep the community informed of cleanup progress and are always available to answer questions and concerns about the Halby Site. EPA will speak with community members and decide how best to communicate Site progress in the future. The community relations plan will be revised to document the community involvement strategy.

Vance Evans, EPA Community Involvement Coordinator, is available to answer questions about the Site and can be reached at (800) 553-2509 or (215) 566-5526, or via e-mail at "evans.vance@epamail.epa.gov".

The DNREC Public Information Officer is also available to answer questions about the Site and can be reached at (302) 323-4540.

EPA established an information repository that allows the public easy access to Site-related documents. There are two information repositories for this Site: Wilmington Public Library, 10th and Market Streets, Wilmington, Delaware 19801, (302) 571-7416 and EPA Region III, 841 Chestnut Street, Philadelphia, Pennsylvania 19107, (215) 566-3157.

EPA mails Site updates and fact sheets to the Site mailing list of local citizens and interested parties. To be added to the list, contact: Vance Evans, EPA Community Involvement Coordinator, 841 Chestnut Street, Philadelphia, Pennsylvania 19107 or (800) 553-2509 or (215) 566-5526.

3. A Wilmington city councilmen stated that EPA has not been forthcoming with information to the public.

EPA Response: EPA respectfully disagrees. As stated previously, public participation is an integral component of the Superfund process. EPA and DNREC have continually performed community liason activities designed to keep the community informed of Site-related activities. In the near future, EPA will prepare a community relations plan that will outline our planned outreach activities during Remedial Design and Remedial Action phases of the project. Prior to finalizing the plan, EPA will discuss informational needs and appropriate communication strategies with interested community members. Additionally through the TAG process information will be disseminated to the public as the response action progresses.

Some of the public education activities implemented by EPA to date have included hosting open meetings with the community, informal interviews conducted by walking through the community and going door-to-door, technical briefings held to inform the Wilmington and New Castle County Local Emergency Planning Committees including local firefighters of relevant events, and preparing and mailing Fact Sheets to everyone within a given radius of the Site as well as anyone on the Site mailing list. In addition, EPA representatives have conducted Site tours with community representatives, including a representative from Wilmington Mayor Sills office. More recently, EPA participated in a Superfund workshop jointly sponsored by the Wilmington and New Castle County LEPCs and provided an informational briefing for the Judicial Committee of the Wilmington City Council. During each contact with the community, EPA representatives routinely inform interested parties how to get additional information. Consistent with standard practice, interested citizens were informed of the local information repository and provided with the name and phone numbers of EPA and DNREC contacts.

4. A citizen expressed concern about the advertisement for the public meeting. She opined that the reason that there was not more people at the public meeting was the newspaper advertisement, flyer and Fact Sheet were worded so that few people would bother to read them. The citizen stated that the language of the public notice was too confusing for the public to understand and recommended that all information about the Site be communicated to the public at a sixth grade reading level.

EPA Response: EPA recognizes the importance of communicating information to the community in an understandable format. EPA will continue in its efforts to make all Site information understandable and readily available to the citizens. In an attempt to get information to everyone in the community EPA has implemented a multi-media approach. In addition to paid newspaper notices, flyers were delivered to the local community centers; Fact Sheets were mailed to everyone in the area, as well as the Site mailing list; a feature article on the Halby Chemical Site was written in the Wilmington New Journal; an editorial ran in the Wilmington News Journal; a letter to the editor from a property owner was printed in the Wilmington News

Journal; EPA representatives participated in television interviews which ran on Channels 2 and 12 discussing the Halby Chemical Site; and, EPA and DNREC representatives participated in a pre-meeting briefing of the Judicial Committee of the Wilmington City Council in effort to more thoroughly involve their constituents with the Superfund process. Based on interviews conducted with residents from the nearest neighborhood to the Site, EPA believes that the residents are aware of the cleanup activities to the level of detail that meets their interest. EPA is committed to working with the local community to keep it informed of Site progress during cleanup.

Part II: Responses to Written Comments

This section provides technical detail in response to comments or questions on the Halby Site. EPA received these comments or questions by mail or e-mail during the public comment period. The following specific comments are addressed:

A.	Comments from Witco Corporation
B.	Comments from Sierra Club, Delaware Chapter
C.	Comments from City of Wilmington, Delaware
D.	Comments from F&H Trucking

A. Comments from Witco Corporation

In a ten-page letter dated September 29, 1997, Mr. Raj Vyas, Corporate Manager of Environmental Remediation for the Witco Corporation, submitted comments to EPA regarding the Halby Chemical Proposed Plan.

1. Witco supports EPA's selection of Alternative S-2 as part of the overall Site remedy for the following reasons:

- human access to affected soils would be prevented,
- affected surface soils would be consolidated with other contaminated soils,
- continued beneficial use of the Site would be maintained,
- off-Site hauling of materials, with the attendant risks from transportation-related incidents is avoided,
- leaching of constituents to the subsurface is prevented,
- the remedy would be compatible with the ongoing treatment of carbon disulfide-contaminated soils at the Site, and
- the remedy is the best alternative relative to the National Oil and Hazardous Substances Contingency Plan selection criteria.

EPA Response: No additional comment.

2. Witco stated that Alternative S-3 is no better than Alternative S-2 and comes with a substantially higher cost. Witco specifically notes that some of the contaminants present at the Site, such as arsenic and carbon disulfide, would be difficult to stabilize.

EPA Response: EPA acknowledges that arsenic is difficult to chemically stabilize and treatability studies conducted to identify an acceptable binder are often lengthy. Commonly, arsenic stabilization projects are only able to achieve physical immobilization rather than true

chemical fixation. EPA has not presented stabilization as a means of reducing the availability of carbon disulfide. The oxidation of carbon disulfide has achieved performance goals.

3. Witco states that Alternatives S-4 and S-5 remove contaminants from the Site only to transfer the risk associated with these materials to another location. In addition, there is no inherent contaminant volume reduction or long-term effectiveness or permanence increase brought about by either of these remedies.

EPA Response: Alternatives S-4 and S-5 would entail the transfer of contaminated soil to modern landfills which have been constructed in accordance with appropriate RCRA regulations. RCRA-characteristic soil would be sent to a RCRA Subtitle C landfill which would likely require treatment prior to landfilling. Contaminated soil which is not RCRA-characteristic would be sent to a RCRA Subtitle D landfill. EPA acknowledges that the short-term risks would be increased due to excavation, handling and transportation; however, containment of materials in modern landfills generally offer a higher degree of certainty with respect to long-term containment. Alternative S-5 would offer no additional reduction in toxicity, mobility or volume. Alternative S-4 would involve separating the fines via soil washing, resulting in a higher concentration (increase in toxicity) and a reduction in volume. The separated fines would likely require treatment prior to disposal in a Subtitle C landfill. EPA agrees that on balance, Alternative S-2 is the best soil remediation alternative when evaluated against the nine criteria.

4. Witco supports EPA's selection of Alternative G-2 for ground water and notes that the State of Delaware, in its letter on July 23, 1997 to the EPA, noted its intention to establish a ground water management zone. The state-enforceable institutional controls would supplement the deed restrictions that the owner of the Halby Site would place on the Site relative to ground water use or disturbance of effected media.

EPA Response: Delaware DNREC has established a ground water management zone in the vicinity of Halby Chemical, the Potts Site and the Port of Wilmington.

5. Witco agrees with EPA's assessment that Alternatives G-3, G-4 and G-5 are not advisable. Primary reasons supporting Witco's rejection of Alternatives G-3, G-4 and G-5 include: the fact that regional ground water issues cannot and should not be resolved by treating ground water beneath the Halby Chemical Site; the ground water presents no risk and the ground water management zone will maintain that scenario; and, the inherent complexities and technical difficulties associated with operating a system which includes the diversity of complex treatment units required to treat the likely sediment- and dissolved solids-laden flow. The most important reason is identified as the fact that there will be no significant environmental benefit from expending the significant resources that would be required to implement these alternatives.

EPA Response: No additional comment. EPA selected Alternative G-2 after it evaluated the ground water alternatives against the nine criteria.

6. Witco conditionally supports Alternatives LM-4 or LM-4A. Alternatives LM-4 or 4-A are protective because they prevent contact of aquatic life with residual sediment contamination and are beneficial to the state because the opportunity to improve wetlands in an area of higher-quality habitat is afforded by both alternatives. Witco believes that during the remedial design, an evaluation of the marsh area may be appropriate to ensure that areas are not remediated unnecessarily if they are no more effected than regional background, as indicated in the draft DNREC report "Sediment Quality Assessment for the Tidal Christina River Basin" or the ecological risk assessment specifies. This evaluation should consider the costs/benefits of further delineation of the affected area, particularly in the southern marsh. Based on this evaluation, the actual remedial alternative selected for the marsh could be a hybrid between Alternatives LM-4 and 4-A.

EPA Response: EPA accepts Witco's support for Alternative LM-4 and acknowledges Witco's greater support for Alternative LM-4A (which is basically the same as that described above). Based on a comparison against the nine criteria, EPA has determined that LM-4 represents the best option. EPA strongly rejects the idea that widespread anthropogenic degradation of marsh areas in other locations along the industrialized Christina River will diminish our resolve to restore wetland habitat which has been degraded by the Halby Chemical Superfund Site. Should the PRP(s) agree to implement the Selected Remedy, EPA and DNREC would not preclude the conduct of additional pre-design bioassay studies developed with the assistance of the Federal and State Natural Resource Trustees and focused in the southern marsh.

7. Witco noted on page 38, paragraph four, of the Proposed Plan that locating an appropriate off-Site parcel for wetlands upgrading would require significant effort and coordination. Witco states that the level of effort for this task may be excessive unless the location of the wetlands upgrade is based on coastal, wildlife corridor, or avian flyway criteria rather than the drainage basin in which the wetlands are located. This is because the Christina River basin may not have the most suitable lands available and because the drainage basin in itself is not an important factor for wildlife population enhancement

EPA Response: EPA and the PRP(s) will need to work with the Federal and State Natural Resource Trustees as well as local government and community representatives in selecting an acceptable location to create the compensatory wetlands.

8. Witco states that it is not advisable to implement Alternative LM-2. The major reasons given to support the rejection of LM-2 are:

- significant risks associated with off-Site hauling;
- due to highly industrial environment, more benefit to the environment can be achieved by restoring or developing a wetland in a higher-quality habitat area;
- the cost offers no increased benefit.

EPA Response: No additional comment. EPA selected Alternative LM-4 after it evaluated the lagoon and marsh alternatives against the nine criteria.

9. Witco states that it is not advisable to implement Alternative LM-3. Witco states that LM-3 is a duplicative remedial approach relative to Alternatives LM-4 and LM-4A because it involves stabilization, which is redundant with the cap placed over the stabilized sediments with respect to leaching control. The costs of LM-3 offer no additional benefit over LM-4 or LM-4A.

EPA Response: EPA agrees that Alternative LM-4 compares better than LM-3 against the nine criteria. EPA's evaluation found that, if treatability studies were able to develop an adequate non-toxic stabilization reagent, LM-3 would offer reduced potential for leaching of contaminants in lagoon and marsh sediments to ground water compared to LM-4. EPA determined that the technical uncertainty related to effectiveness and the $44, 000,000 implementation estimate associated with LM-3 make LM-4 a superior choice.

10. Witco stated that the risks associated with the marsh area are overstated. Specifically, risk to wading birds are overestimated, and the toxicity observed in the benthic studies were not linked to Site-related constituents, therefore the impacts on aquatic life are overstated. Witco cites a draft report assessing Christina River sediment quality in asserting that aquatic toxicity and arsenic levels in the River do not correlate well.

EPA Response: EPA respectfully disagrees that the risks associated with the marsh area are overestimated. The high mortality rates observed when acute bioassay studies were conducted with sediment collected from the on-Site lagoon and north and central tidal marsh obviated the plan to conduct chronic bioassay studies in the area. EPA did not proceed to quantitatively assess the effect of sediments on reproduction or other non-lethal effects due to the high mortality rate. Additional laboratory studies designed in an effort to identify a specific contaminant in the sediments which is causing the toxicity failed to highlight a single contaminant, suggesting that multiple contaminants are involved. Let it be known that EPA does not assert that it is aware of <u>all</u> chemicals which have historically been used in the Halby Chemical production facilities or laboratories. Historically, the Halby Chemical facility discharged its aqueous wastes to the on-Site lagoon which proceeded to flow beneath the railroad tracks to the northern marsh, through the central marsh, through the southern marsh and out to the Lobdell canal. EPA has observed that aquatic toxicity is greatest in the on-Site lagoon and the north and central tidal marsh which are the areas likely to have been subjected to the highest concentration of Halby Chemical plant aqueous wastes. Although arsenic is the only contaminant identified at a level of concern in lagoon and marsh sediment with respect to human health, arsenic is one of many compounds of concern with respect to aquatic life. EPA does not assert that arsenic is the sole contributing factor to the observed acute toxicity; accordingly, the relevance of Witco's observation regarding a draft report assessing Christina River sediment quality is unclear. A quantitative ecological risk assessment was not performed for wading birds; however, wading birds are potentially at elevated risk when accessing the on-Site lagoon and marsh wetland habitat. Wading birds that feed on aquatic organisms and inadvertently consume sediments are potentially exposed to contaminants which tend to bioaccumulate, such as mercury. During decontamination of the abandoned laboratory at the former Halby Chemical production facility, EPA removed a bottle of metallic mercury for proper off-Site disposal.

11. Witco pointed out that arsenic levels higher than those in the vicinity of the Halby Site and high toxicity levels are also present elsewhere in the tidal basin. Witco stated that these findings indicate that the Site's impact on surface water is within the range of conditions observed elsewhere in the tidal reach of the Christina River.

EPA Response: EPA does not assert that the Halby Chemical Site is the only source of anthropogenic chemical degradation in the tidal reach of the Christina River. This fact does not diminish, but rather elevates, the importance of preventing exposure of ecological receptors to potentially harmful chemicals associated with the Halby Chemical Site.

12. Witco supports Alternative D-2. Witco commented that further action for Dense Non-Aqueous Phase Liquids ("DNAPL") remediation is unnecessary for the following reasons:

- The on-going carbon disulfide treatment will remove the principal mass of carbon disulfide from the Site; and
- The alternatives that focus on DNAPL recovery may be inapplicable, as it has not been observed that DNAPL actually exists in the Columbia Formation.

EPA Response: EPA acknowledges that the strongest evidence that free phase carbon disulfide is present in the subsurface was found in the uppermost 12-14 feet within the carbon disulfide treatment zone. Recent testing has confirmed that the chemical oxidation program completed by Witco in January 1998 has successfully removed a significant mass of carbon disulfide from the environment.

13. Witco approves of EPA's intention (p. 4 of the Proposed Plan) to supersede the Operable Unit 1 ROD with the ROD for Operable Unit 2, assuming that the ROD for OU2 incorporates the remedy for the carbon disulfide affected shallow soils presently being implemented.

EPA Response: The carbon disulfide treatment program has been an integral part of EPA's overall remedial strategy addressing risks presented by the Halby Chemical Site. EPA determined the free phase carbon disulfide mass located just below the ground surface to present a potential immediate threat to human health and the environment. Accordingly, EPA determined that immediate action to mitigate that threat was warranted. The carbon disulfide treatment program was discussed prominently throughout the Proposed Plan. In effect the carbon disulfide treatment component is a "common element" to each of the remedial alternatives evaluated to address the risks presented by Site soil.

14. Witco stated that it appears that some of the risks in the Proposed Plan may be overstated. Specifically, p.10 of the Proposed Plan notes that recent soil data for within the carbon disulfide treatment zone indicate higher-than-expected concentrations, leading to an underestimation of risk for carbon disulfide. However, the Proposed Plan should also have noted that these concentrations are being remediated as part of the removal action. In fact, carbon disulfide-related risks will be significantly lowered. Furthermore, risk assumptions are traditionally highly conservative, such that risks are rarely underestimated in actuality.

EPA Response: EPA agrees that risk assessments are generally conservative by design precisely so that risks are not underestimated. The quantitative Risk Assessment completed for the Site and presented in the Proposed Plan incorporated environmental data collected through September 1995. The language EPA included at p.10 of the Proposed Plan acknowledged that data collected from intensive sampling completed by Witco after September 1995 was not included in the quantitative Risk Assessment. At the time that the Proposed Plan was released, EPA had information indicating that carbon disulfide concentrations were present at levels greater than those incorporated in the Risk Assessment. EPA accepts that the risk presented by carbon disulfide contaminated soil is currently lower than the risk assessment estimate due to the successful carbon disulfide treatment program completed by Witco in January 1998. For the record, EPA did explicitly note that carbon disulfide was being addressed under a removal action. See p. 5 of the Proposed Plan, "The carbon disulfide in soil is already being addressed as part of an ongoing removal action. It is assumed that the carbon disulfide located down to 12 feet below the ground surface will not be an environmental problem which needs to be addressed in this Proposed Plan as it will be removed during on-going removal action." EPA's Selected Remedy identified in the OU-2 ROD is the proposed final remedy for the Site and takes into consideration response actions either on-going or completed at the Site.

15. Witco stated that the pathway of human consumption of ground water is not plausible.

EPA Response: EPA agrees that the potential for human consumption of carbon disulfide in ground water beneath the Halby Chemical Site is no longer plausible. However, during the Risk Assessment exposure pathways are considered regardless of institutional controls already in place. Once the risk is assessed, institutional controls are considered during the remedy evaluation. If Delaware DNREC had not implemented a ground water management zone to prevent the installation of drinking water wells on the property, the exposure could have theoretically occurred.

16. Witco recommends that the Proposed Plan provide, as part of its short-term effectiveness discussion, a quantitative evaluation of short-term risks in implementing each remedy arising from excavation and transportation risks.

EPA Response: EPA accepts the premise that transportation of hazardous substances does have an inherent risk associated with the potential for traffic hazards which can be minimized but not eliminated. EPA has added a qualitative discussion addressing the increased risk associated with transportation hazards to this OU-2 ROD (see Section VIII.E). EPA does not believe that quantitative evaluation of risks associated with transportation hazards is necessary because the qualitative evaluation offers sufficient understanding for the purpose of comparative analysis. EPA's Selected Remedy will not include any significant off-Site transportation.

17. The Proposed Plan, page 13, paragraph one, states that there is a clear concentration gradient from the Site toward the Lobdell Canal for arsenic, cadmium, copper and zinc. The feasibility study ("FS") states, in contrast, that arsenic was distributed erratically in the marsh. Figure 1-21 on the FS indicated erratic distribution of arsenic and copper between the

lagoon and marsh (cadmium and zinc are not shown in the figure). The erratic distribution demonstrates that there is not a clear source of the elevated levels observed.

EPA Response: When evaluating sediment data, the Ecological Risk Assessment calculated an Environmental Effects Quotient ("EEQ") for each contaminant within the on-Site lagoon, the north/central marsh and the southern marsh using the maximum concentration identified in the respective area. EEQs were generated by dividing the maximum concentration by conservative screening values. The resulting EEQs for arsenic, cadmium, copper and zinc were presented in Figure 7-2 of the Ecological Risk Assessment. Figure 7-2 demonstrates a gradient trending from high to relatively low concentrations for each of the above named contaminants as we move from the point of historic aqueous waste discharge toward the Lobdell Canal. For example, EEQs for arsenic were calculated at 379, 105 and 11 for the on-Site lagoon, northern/central tidal marsh and southern tidal marsh, respectively.

Unlike liquid media which tend to be well mixed and, as a result, yield a "smooth" curve transition of concentrations from sampling point to sampling point, solid media frequently generate variable concentrations from sampling point to sampling point even when two points are very close together. The literal description of data included at page 1-41 of the FS, that the "concentrations of arsenic and beryllium in the tidal marsh were distributed erratically...," is not false; however, both statements are incomplete interpretations of sediment data. If we average concentrations for each contaminant within the on-Site lagoon, the north/central marsh and the southern marsh in an effort to eliminate the "noise" created by the discrete sample results, a trend moving away from the former discharge point is apparent. For example, the average concentration of arsenic within the on-Site lagoon, the north/central marsh and the southern marsh calculates to 750 mg/kg, 160 mg/kg, and 76 mg/kg, respectively.

18. The Proposed Plan on page 31, states the southern marsh area contains several inorganics at levels in sediment "many" times greater than the levels known to be safe. Given the "erratic distribution" of inorganics in the southern marsh area, this statement should be qualified to state that this was the case at selected locations. For example, arsenic and copper levels in sediment vary from below acceptable levels within the lagoon and marsh to well above these criteria, depending on the location sampled.

EPA Response: EPA accepts Witco's assertion that there are individual sediment samples collected at discrete locations which do not contain an unacceptable concentration of hazardous substances. However, interpretation of sediment data requires analyses of, at minimum, proximal areas. As mentioned above, to summarily describe the sediment data as yielding "erratic" distribution would be to ignore the contaminant trends requisite to interpretation of sediment data.

19. On p. 34, paragraph 2 of the Proposed Plan it is noted that the Occupational Health and Safety Administration hazardous waste worker safety requirements apply to all alternatives that involve contact with soil, sediment, ground water, or residual sludge. This statement implies that all affected media are characteristically hazardous, which is not necessarily the case, depending on the site location. The Proposed Plan should state that OSHA compliance is included as a standard requirement on all Superfund sites.

EPA Response: EPA agrees that OSHA compliance is included as an applicable requirement for all Superfund clean-ups.

B. Comments from the Sierra Club, Delaware Chapter

In a one-page letter dated September 29, 1997 Ms. Regina Katz, Co-Chair of The Delaware Chapter of the Sierra Club, submitted comments to EPA regarding the Halby Chemical Proposed Plan.

1. What type of coordination has been implemented with respect to the remediation plan and the Whole Basin Management Plan for the Piedmont with DNREC and the City of Wilmington? How will the contaminant sources that are being released through the ground water be integrated into the Piedmont Whole Basin Management Plan for the State of Delaware?

EPA Response: The Whole Basin Management Plan ("WBMP") for the State of Delaware divides the State into five drainage areas, or major watersheds. Delaware has created five basin teams made up of representatives from each of the divisions within Delaware DNREC and representatives from local governments. A general summary of the intent of the WBMP is to identify all potential sources of contaminants to the respective major water basin, complete intensive monitoring where necessary to complete the understanding of contaminant loading, evaluate the overall "health" of the water basin and identify the most significant problems yet to be addressed, and finally, to develop strategies to minimize the identified problems. The plan for each water basin will take place in eight sequential phases and is expected to take several years to complete.

The Halby Chemical Site lies within the Piedmont Basin which is the first of the five basins to be addressed by Delaware DNREC. The Piedmont project began in 1996 and is currently in the preliminary assessment and intensive monitoring phase. Our coordination is accomplished by having Mr. Dave Langseder, a representative from DNREC's Air & Waste Management Division, on the Piedmont Team. Mr. Langseder has participated in the database assembly and has identified the Halby Chemical Site and the adjacent Potts Property State Superfund Site as potential sources of contamination for entry into the database being compiled for the Piedmont.

The Halby Site is located approximately 1/3 of a mile away from the Christina River and therefore does not have ground water discharging directly to the River. As stated in the Proposed Plan the investigation of the Potts Property State Superfund Site, located between the River and the Halby Chemical Site, will evaluate the effect of ground water discharged to the Christina River. A small percentage of the contaminants flowing to the river along the Potts Site through natural ground water discharge likely originate from the Halby Chemical Site. Again, this information being generated as part of the Potts Site investigation will be available to the Piedmont Team.

Representatives from Delaware DNREC, including members of the whole basin management team reviewed and commented on the Draft Proposed Plan for the Halby Chemical Site prior to its release for Public Comment.

EPA has communicated and coordinated Halby Chemical cleanup activities with the City of Wilmington throughout the process through on-Site briefings held with Wilmington LEPC representatives. EPA has conducted several special briefings for City officials focusing on the Halby Chemical Proposed Plan, including meetings with the LEPC, the Mayor's office representatives and members of City Council.

2. What are the other sources of contaminants that exist within the watershed and what kind of model is being used to assess the background levels?

EPA Response: This is well beyond the scope of the Halby Chemical Site analysis and may be best addressed by the Piedmont Team after their database is complete.

3. What effect will the continued release of contaminants through the ground water have on the Total Maximum Daily Load of emissions for non-point source pollution to the Christina River?

EPA Response: The Halby Chemical Site is located approximately 1/3 of a mile away from the Christina River and therefore does not have ground water discharging directly to the River. The investigation of the Potts Property State Superfund Site, located between the River and the Halby Chemical Site, will evaluate the effect of ground water discharged to the Christina River. A small percentage of the contaminants flowing beneath the Potts Site to the river through natural ground water discharge likely originates from the Halby Chemical Site. The intermingled nature of contaminants from the neighboring industrial parcels make determining a definitive contaminant load eminating from the Halby Chemical Site and discharging to the River near impossible.

The completion of the Potts Site investigation and the Piedmont contaminant source database should enable DNREC to quantitatively assess the significance of the collective ground water discharge relative to the total daily load to the River. The mass loading due to the small volumetric ground water discharge relative to the large flow rate within the River is likely resulting in no adverse effect on River water quality, however no definative assertion can be made at this point.

4. Does the Site lie within a flood plain? If so, what plans have been developed to deal with flooding of this area?

EPA Response: A portion of the Site lies within the 100-year flood plain (i.e., areas less than 10 feet above mean sea level). The soil containment option included in EPA's Selected Remedy will prevent off-Site migration of contaminated soil and sediment via erosion. The construction will be designed so to conform to the Delaware Stormwater and Sediment Control Regulations as they apply to activities within the 100-year flood plain. The specific plans will be developed during the Remedial Design phase of the project.

5. Has there been any study of the occurrences of bioaccumulation for complex contaminants?

EPA Response: Fish tissue, both whole fish and fillets, was evaluated for fish caught in the on-Site lagoon and an off-Site (background) location. Zinc and methylene chloride concentrations were higher in the lagoon samples than background but not at levels which would lead to elevated risks to people eating the fish (assuming that the fish were large enough to eat). 2-Butanone concentrations were higher at the off-Site location. All other contaminants exhibited little difference. Implementation of the Selected Remedy will greatly reduce the potential for bioaccumulation of Site-related contaminants by preventing exposure of ecological receptors to contaminated soil and sediment. Wetlands habitat will be enhanced or created at an off-Site clean location.

6. Have contaminants been sampled in the aquatic life in the watershed, specifically in the aquatic life that is recognized as a subsistence food source for low income residents of this area?

EPA Response: The on-Site lagoon and adjacent marsh have average depths of approximately 1 foot and are primarily mud flats at low tide. The fish captured for study were the size of minnows and due to their size are unsuitable for eating by subsistence fishermen. The Halby Chemical investigation did not include fish collection from the Christina River. If the fish collected in on-Site lagoon had demonstrated potentially problematic concentrations of Site-related compounds, additional fish would have been collected from the Christina River to quantify potential human health risks due to fish consumption.

7. Has there been any evaluation of the employees of the Port of Wilmington or any of the surrounding communities for any human health effects related to exposure to the pollutants identified in the plan?

EPA Response: EPA conducted a human health risk assessment focusing on current and potential future risks presented by the Site. The risk assessment findings indicate that an elevated risk is presented to on-Site workers, construction workers (doing subsurface digging on the Site), and trespassers who come on to the Site property. Persons must come on to the property and come into direct contact with contaminated soil or sediment to be at risk due to elevated arsenic concentrations at the Site.

Mr. Jack Kelly of the Agency for Toxic Substances and Disease Registry has conducted some preliminary interviews with a few citizens who felt that they may have been exposed to hazardous substances released by the chemical plant during the production years, primarily the 1950s and 1960s. It is EPA's understanding that this inquiry continues; however, this is outside the scope of EPA's response activities.

8. Are there any species of fin fish that are under a federal or multi-state management plan or any federally listed candidate, threatened or endangered species effected by any aspect of the remediation plan?

EPA Response: No particular species which have been called out by government protection programs will be affected by implementation of the remediation plan. Nevertheless, numerous anadromous and resident fish species utilize the Christina and Delaware Rivers and adjoining wetlands near the Site as adult habitat, spawning and nursery areas, and migration routes. Although the Site is 1/3 of a mile from the Christina River, the preservation of quality wetland habitat along the Christina corridor is vital to the health of the fishery. Implementation of EPA's remediation plan will reduce the potential for exposure of all fin fish to unhealthy conditions currently existing in the waterways degraded by past Site activities. A wetland area of equal functional value will be created at a more appropriate location to restore this vital resource within the watershed.

C. Comments from City of Wilmington, Delaware

In a four-page letter dated September 29, 1997, Mr. Thomas G. Noyes, Executive Assistant to the Mayor, City of Wilmington ("Wilmington"), submitted comments to EPA regarding the Halby Site and the proposed remediation plan.

1. The City recognizes that the portion of the Halby Chemical Site located within the city limits is zoned M-1 (light manufacturing) and that standards for remediation are, in part, determined by the future use of the property involved. Nevertheless, the City of Wilmington is interested in promoting and maintaining a level of environmental health on the Christiana River consistent with current and projected retail, cultural, entertainment, and recreational activities along the City's waterfront. Wilmington hopes the clean up at Halby contributes to the improvement of the overall Christina River environment.

EPA Response: EPA is in full accord with the City of Wilmington on this matter. Implementation of the Selected Remedy will stem the potential for off-Site migration of contaminated soil and sediment and prevent ecological receptors from being exposed to unhealthy conditions while visiting chemically degraded wetland habitat.

It has been mentioned on several occasions that the Halby Chemical property is zoned for industrial use and the current property owners claim every intention of maintaining that status. However, for clarity, EPA notes that the asphalt capping remedy may also be appropriate for retail, commercial or other specific uses should the stakeholders determine a land use change is appropriate. The substantive restrictions for future use of the property relate to preventing exposure to contaminated soil and sediment; therefore, maintaining the integrity of the cap is paramount. A mechanism will be established to ensure that workers are aware of the presence of hazardous substances beneath the cap so they are properly trained and protected during any subsurface construction work necessary at the Site.

2. The City of Wilmington would like to commend EPA for the ongoing remediation including the removal of the large carbon disulfide storage tank from the property and neutralization of the carbon disulfide in soil. The ongoing testing of the carbon disulfide in the soil indicates that the neutralization method is successfully lowering the concentration of carbon disulfide to safe levels as defined by EPA.

EPA Response: EPA would like to add that the carbon disulfide treatment project is now complete (January 1998). Sampling has confirmed that the project was a success and that the concentration of carbon disulfide in treated soils is now at levels that are safe for Site workers.

3. The City of Wilmington stated it understands the principle of compensating for the loss of wetlands on one site with wetlands creation at another location. The City believes that the replacement wetlands should be located in the Christina watershed as close to the Halby Chemical Site as possible. The City reaffirmed its commitment to preserving the wildlife habitat and natural cleansing properties that wetlands provide and believes that the compensatory wetlands will benefit the Christina River watershed.

EPA Response: EPA agrees with the City's comment. EPA and the PRP(s) will need to work with the Federal and State Natural Resource Trustees as well as local government and community representatives in selecting an acceptable location to create the compensatory wetlands.

C. Comments from F&H Trucking

In a one-page letter dated August 21, 1997, Mr. Herbert R. Bollman, President of F&H Trucking, submitted comments to EPA regarding the Halby Site and the proposed remediation plan.

1. F&H Transport attended the public meeting and has read all the literature that EPA has made available to the public over the years. Through these efforts, F&H Transport has come to realize the full extent of contamination on the Site and each of the potential options to clean the Site up. F&H Transport feels that EPA's preferred cleanup plan is the most appropriate option. EPA has studied the Site since June 1986, there has been ample time for the public to become involved and give their opinions to the EPA. Therefore, F&H transport believes that EPA should go forward with the plan as it is.

EPA Response: No additional comment. EPA has determined that, based on a comparison against the nine criteria, the Selected Remedy represents the best option.